THESIS

MIND AND METHOD:

AN EXAMINATION OF COGNITIVE ACTIVITIES IN THE DESIGN PROCESS

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ABSTRACT

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The creative process is a multifaceted and dynamic path of thinking required to execute a project in design-based disciplines (e.g., interior design, architecture). Social scientists have studied stages of the creative process; however, little comparative work has been conducted on the stages of the production process and increased creative design outcomes. This research seeks to understand phases of the creative design process by investigating design student experiences through a project assignment.

This study used an exploratory design to collect qualitative data from demographic information, journal responses, and creative product results from college students enrolled in a design studio. The study conceptualized a creative process model based upon comparison and analysis of ten seminal and contemporary creative process models. Models were characterized by number of stages and grouped according to the transitional nexus between analysis and synthesis forming a common baseline. Four distinct categories were revealed based on the number and complexity of stages as: simple, balanced, complex

analysis, and complex synthesis. Amabile's (1996) Components of Creativity model encompassing constructs of domain experience, motivation, and creativity-relevant skills was referenced in examining student processes which were then compared to the proposed model.

Thirty-six senior level interior design students in a Council for Interior Design Accreditation (CIDA) program participated in the assignment. Of these, 34 consented to participate; the final number of participants responding to journal prompts in the time frame requested further reduced the number of participants, resulting in $N = 20$. Students were asked to design a lounge chair during a two week period and to journal in response to pre-determined question prompts regarding their activities. Using template analysis, codes were derived for task activities. A scaled furniture model and accompanying design process board was reviewed by external evaluators to identify level of creative output. Two distinct groups demonstrated high and low creativity. Tasks, demographic data, and level of creativity were then compared by this criteria and the proposed model reexamined.

Demographic data and journal responses illustrated differences between the high and low creativity group. GPAs, transfer credits, and total credit hours were higher for the high creativity group in addition to evidence of higher levels of abstract thought and greater divergent thinking. Students in the high creativity group also demonstrated increased depth in thought and higher motivation throughout their creative process.

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CHAPTER I

INTRODUCTION

"Creativity has always been at the heart of business" (Amabile & Khaire, 2008, p. 100). In the new century, when browsing management-related periodicals; one cannot fail to notice the importance of creativity and innovation to modern business organizations (Driver, 2001; Jeanes, 2006). Creativity can be used to solve complex problems, ideate intelligent solutions, and gain a competitive edge in the marketplace. There is a perpetual relationship between creative thinking and the process of design. Professional domains including education, philosophy, and psychology have used the design process to aid in development of creative thinking (Labat & Sokolowski, 1999); and in-turn, creative thinking has been used in the design process to foster generation of original ideas (Dorst & Cross, 2001).

Definitions of design reveal a common thread of reasoning regarding the nature of design as an innately creative process (Buchanan, 2001; Lawson, 1997; Portillo, 2002; Silverstein, 1993; Swann, 2002). Creative thinking is especially important to design organizations including architectural, interior, graphic, and industrial design firms; further demonstrating design as an inherently creative pursuit (Lawson, 1997). Design firms look for ways to rise above and differentiate

themselves from their competitors; by harnessing creative design solutions, a firm's processes and products can ultimately lead to market leadership.

Substantial disagreement continues concerning *how* designers produce designs. Dorst and Dijkhuis (1995) suggest two basic and fundamentally different ways of approaching the design process - the Rational Model (Pahl & Beitz, 1996; Simon, 1969) and the Action-Centric Perspective. In the rational model, a sequence of phases occur which are not actual steps followed by designers in conducting works, but a representation of phases through which the design process progresses. In contrast, the action-centric model finds designers using creativity and emotion to generate design ideas through improvised processes with no apparent universal stages. Empirical evidence supports this perspective in describing the actions of practicing designers in certain disciplines, e.g., engineering and education (Cross, Dorst, & Roozenburg, 1992; Ralph, 2010; Schön, 1983).

A connection between design and creativity can also be identified in the job market. Practitioners, identified by their firms as creative, often occupy positions of great influence within their respective workplaces. Students perceived to be highly creative are also sought after by prestigious design firms. A symbiotic relationship of design to creativity appears to be especially true within the discipline of interior design. In a comparative study of implicit theories found within the professions of interior design, architecture, landscape architecture, and engineering; findings indicated interior design was perceived by other professionals to be the most artistic, curious, energetic, sensitive, and spontaneous when compared to the other disciplines (Portillo, 2002). In increasingly competitive environments, novel and

appropriate solutions are sought and creativity highly valued. Under Interior Designer qualifications, the U.S. Bureau of Labor Statistics states “In addition to possessing technical knowledge, interior designers must be creative, imaginative, and persistent and…able to communicate their ideas visually, verbally, and in writing” (2009).

Consider, if only 10 students, on average, graduate from the 150 Council of Interior Design Accredited (CIDA) programs annually, 1,500 new designers could potentially seek entry into the interior design profession each year (Council for Interior Design Accreditation, n.d.). Creative traits, then, become ever more important for design graduates to remain competitive with peers and more experienced practitioners. Pinpointing creative processes and thinking skills utilized while designing could inform and deepen an understanding of how creativity can be enhanced in the design products of students, recent graduates, and current practitioners.

Although a relationship between creativity and success in the design industry can be identified, there remains fundamental confusion about the design process and terminology regarding creativity. The process of design is not transparent regarding how designers make decisions, what steps are taken, in what order, and even by what terms are used to define these steps. Research on the design process can further aid students and practitioners in focusing efforts to attain the talent, skills, and cognitive thinking processes needed to obtain high caliber positions in the design profession and to produce novel solutions to meet the challenges of the global economy.

Although, empirical studies have been conducted on the creative process, none have utilized authentic first person accounts. A majority of studies were conducted in which the creator was recorded or must "speak aloud" (Lawson, 1997). In other studies, researchers analyzed drawings and gestures (Dorst, 1995; Krueger & Cross, 2006). These methodologies are inherently flawed as it is difficult for a subject to verbally account for their own processes while actively engaged in a design problem, and neither gestures nor drawings alone can fully account for the actual steps and sequences taken during the creative process. Studies have also been conducted within time frames of hours, thus, limiting the exposure to external influences or feedback opportunities. These research examples also lack self-reflection of the designer's efforts during or after the process.

There is much to be learned about the process of design to understand how creative thinking is utilized during design activities. Comparisons of actions, sequence of patterns, and decision-making characteristics may reveal common paths and pedagogical factors for educators to better understand the processes undertaken by their students in solving design problems. Heightened understanding may also assist current and future designers to better comprehend and execute their own process. Reflection, as a tool reinforcing learning, can be used to achieve greater measures of success in future problem solving endeavors by heightening self-awareness of design activities experienced during problem-solving. Reflective journaling, as a means to share learning, can increase the understanding of actions taken to give designers a competitive edge in the market place (Christianns, 2002; Florida & Goodnight, 2005) at a time when success in the

design industry may depend on small differences in the way design is executed. The value of reflection in the design process can be viewed as opportunity for:

a) exploration of meaning behind one's actions altering choices; shared learning, from the environment and with the client;

b) connecting current process with other design experiences;

c) clarifying client and team goals and values;

d) emphasizing personal strengths as well as areas for improvement (e.g., skills, communication and delivery); and,

e) constructive self-evaluation of solutions (Boud, 2000; Epstein, 2000).

Statement of the Problem

Entry level designers require and search for a competitive edge in seeking employment. Increased understanding of students' creative processes could enhance student preparation by more effectively teaching and preparing students in demonstrating creative thinking and production of creative output. Understanding design thought processes can impact and improve design performance (Dorst, 1995). A challenge is to concretely identify decision-making patterns distinguishing creative problem solutions from those that simply solve the problem. In this research, attention will be paid to the connection between process and product, identifying differences and similarities in processes resulting in creative products.

As an intrinsically creative process, design is particularly well-suited to alternative research methods, such as reflective journaling (Buchanan, 2001; Lawson, 1997; Portillo, 2002; Swann, 2002).

Purpose of the Study

This research study explores the creative processes implemented by senior level interior design students assigned to creatively design and develop a solution for a lounge chair. Students, in their fourth year of a CIDA accredited program, undertook this two week assignment which included reflective journaling as a mechanism for learning. The objectives of the study were:

a) documentation of the creative process followed by individual participants;

b) comparison of cognitive processes utilized as participants engaged in the process of designing; and,

c) testing of a proposed conceptual model of the creative process correlated to the Components of Creativity (Amabile, 1996) derived from empirical research; and, distinguishing processes and actions resulting in a higher level of creativity in design products as perceived by an external evaluation.

Based on these objectives, the purpose of the study is twofold; to connect actions with outcomes to determine a best fit sequence for creative problem solving; and testing of the proposed conceptual model.

Assumptions

Students enrolled in an interior design program at large in a western land grant institution are thought to be inherently creative to a certain degree, and their design products are also anticipated to be creative in nature. Students in this program are formally evaluated for their potential to succeed in the major in April of their first year, after passing two introductory courses encompassing drawing and an introduction to the interior design profession. Creativity can be identified as a

component of the Design Scenario[1] in several areas including: writing, drawing, and conceptual development.

A second assumption anticipated that students would utilize Amabile's (1996) three Components of Creativity (domain experience, motivation, creativity relevant experience) during the creative problem-solving process. It was anticipated usage of these three components would vary and be influenced by the stages employed, individual demographic contributions in terms of # credits, and domain experiences external to classroom learning (# credits, study abroad experience). Finally, it was assumed all participants would use diverse inputs and resources, and it is anticipated that the creative process will be similar across participants.

Research Questions

The following research questions frame the study:

Q1: What stages of the design process are utilized by the student cohort?

Q2: What activities of the process are similar or dissimilar?

Q3: Are unique strategies implemented?

Q4: Do certain influences produce a better product?

Terms and Definitions

The following terms were used in this study to create contextual understanding:

creative outcome : products of a creative process that are both novel to, and appropriate for, their designated use (Amabile, 1983)

[1] The Design Scenario is a formal entrance evaluation to advance into the major, with students asked to draw, write, solve problems, and conceptualize over a four hour period.

creative process : the activities and task in which one is involved during the production of a creative product (Guilford, 1950)

creative thinking : a subset of thinking, encompassing cognitive processes that result in creative products

creativity : the production of novel and useful ideas in any domain (Amabile, 1996)

creativity relevant skills : a group of skills encompassing cognitive styles and the knowledge of heuristics used to create novel ideas (Amabile, 1996)

design factors : tools used to assist in the process of developing a planned solution

design stage : phase of action along the continuum of a creative design process

design process : the steps taken by designers during the course of a design problem (Lawson, 1997)

divergent thinking : the discovery and identification of alternatives (Evans, 1993)

domain experience : a component of creativity encompassing factual knowledge, talents, and technical skills in a given domain (Amabile, 1996)

heuristics : general guidelines or shortcuts that can be of aid in approaching problems or tasks (Amablie, 1996)

identified motivation : "the desire to do an activity as a means to some end that one greatly values or deems highly important" (Kasof, Chen, Himsel, & Greenberger, 2007, p. 106)

reflection : consideration of previous activities and critical assessment of relationship of process to product outcome

talent : a special skill for which an individual appears to have natural aptitude (Amabile, 1996)

task motivation : a component of creativity including the attitude of a person when approaching a design problem (Amabile, 1996)

quotidian : ordinary, small-scale progressions

Research Perspective

I entered graduate studies with a sequence of design related experiences affecting my perspective on the current study. My undergraduate degree is in Interior Architecture and Product Design and education included several courses in furniture design and fabrication. I studied architecture and urban planning at České vysoké učení technické v Praze, (Czech Tech University) in Prague, Czech Republic. I began graduate work after approximately five years of experience with a large commercial firm evaluated as #1 of the Top 100 Giants by Interior Design Magazine annually. Professionally, my projects have included design and development of workplaces, professional service organizations, and airports; where furniture selection, design, and specification were included in the scope of work. I have also taken a graduate seminar focusing on creativity and it's applications to education, practice, and the workplace.

The study is framed by an interpretivist perspective (Taylor & Callahan, 2005); guided by this philosophical position, the participants construct a view of creativity, each contributing to the perceived reality of the design process. Therefore to comprehend the process of design, these realities require understanding. This perspective seeks to better subjectively understand the individual processes used by student participants with limited domain relevant skills.

My bias in the study is a perception that increased domain experience, motivation, and creativity relevant skills will positively impact the cognitive processes used to form the outputs in a creative design process. In my experience,

there is a positive correlation between high levels of creative components and high levels of creative output in product.

Delimitations

This study was limited to fourth year senior capstone participants enrolled in this CIDA accredited Interior Design program of study at Colorado State University in Fort Collins, Colorado. As an explorative study other participants, programs, and schools were excluded to enable the student cohort to receive similar instruction, direction, and environmental cues through the curricula and be recipients of a relatively similar professional educational background. Participants were engaged in a two week design problem involving the sustainable design of a lounge chair as part of their regular course activities. The project occurred in the fourteenth through sixteenth week of a sixteen week fall semester studio course in 2010. Prior to the study, students had participated in several commercial and residential design projects, completed a major programming exercise for their capstone projects, and undertaken a service-learning experience requiring journaling and reflection. The cohort possessed applied knowledge of several 2D and 3D design software tools demonstrated through application in past project assignments.

To study the components of creativity and the design process, the literature review began by examining seminal work on creativity and motivation by Amabile and colleagues to study the components of her model in greater detail. Empirical research on creativity (problem-solving, thinking) and published design processes were then examined (Aspelund, 2010; Brown, 2009; Harris, 2002; Koberg & Bagnall, 1981; Krueger & Cross, 2006; Labat and Solowski; 1999; Lawson, 1997;

Poldma, 2009; Strzalecki, 2000; Wallas, 1926). Textbooks used to teach the design process to undergraduate students were also reviewed to gain insights into what patterns the students may have referenced in application of problem solving approaches (Aspelund, 2010; Kilmer & Kilmer, 1992; Poldma, 2009).

CHAPTER II

REVIEW OF LITERATURE

Creative process stage models seek to enhance problem solving efforts by formalizing a protocol for activities. Much research has been devoted to creativity and design process models, yet creative problem solving remains elusive in terms of a step sequence resulting in higher levels of creative output. Empirically tested prescriptive models have led to an understanding that principles of cause and effect are at work during the process (Santanen, Briggs, & De Vreede, 2004); however, little comparative work has been conducted on the sequence of activity stages of the creative design process focusing on increasing creativity in the outcome of the design product. The development and documentation of a realistic, practice-based creative process model that considers the sequence of steps and types of design decisions being made, and it's impacts on creativity in solving a design challenge would greatly benefit design students, practitioners, and their clients.

Previous creative process research is challenging in comparing findings due to confusion of terminology. Certain terms have been used interchangeably or remain poorly defined. Exacerbating this confusion, researchers and academics have referred to the creative process as the 'design process' (Aspelund, 2010; Lawson, 1997; Poldma, 2009); and a 'problem solving process' (Harris, 2002;

Koberg & Bagnall, 1991). Researchers have defined creative activities that occur as a 'process' (Koberg & Bagnall, 1991; Lawson, 1997); or as a 'model' (Lubart, 2001). Within the conceptualization of the creative "process" several researchers have defined activities in terms of 'phases, steps' (Harris, 2002); 'stages' (Aspelund, 2010; Wallas, 1926); or 'concepts' (Poldma, 2009). Additional conflicts in terminology include naming of elements comprising creativity as 'components' (Amablie, 1996), 'factors' (DiLiello & Houghton; 2008), or 'constructs.' Terms such as creative thinking, and critical thinking have also been used interchangeably. In actuality, the two terms have distinctly opposing characteristics; creative thinking is explorative, innovative, and unconstrained; where critical thinking is focused, pragmatic, and constrained. Despite an appearance of moving toward one as a departure from another, an individual can exhibit high levels of each (Nickerson, 1999). A clear and common definition of 'creativity' terms is needed, inviting study of creativity and the creative process.

Guilford's (1950) seminal definition of the *creative process* describes the construct of creativity, used in this study, as the sequence of thought and actions producing novel, adaptive solutions. Actions within the creative process are referred to as *stages* encompassing multiple tasks. The traits and skills which compose creativity are referred to as *components*.

Theoretical Foundations Framing the Inquiry

Guilford (1950) proposed skills, personality characteristics, and motivational levels as important determinants to creative behavior. His early conceptualization of creativity did not consider societal and environmental influences affecting the

creator, identified in this study as the designer, or their level of motivation. Amabile's (1996) three Components of Creativity considers Guilford's proposal and includes expanded influences focusing on social factors and the work climate. The constructs of domain experience, creativity-relevant skills, and motivation; shape the foundation of Amabile's theoretical assumptions about the creative process. It is at the intersection of these three components the highest levels of creative output can occur. These three components exist at varying degrees of specificity:

a) creativity-relevant skills, function at the most universal level and can influence responses in any content domain;

b) domain-relevant skills, function at an intermediate level of specificity and include all skills relevant to a general field of inquiry and not just to those related to the specific task; and,

c) task motivation, functions at the most specific level to a given task (Amabile, 1996).

Researchers have presented both formal and informal observations pertaining to the assumptions of creativity:

a) There is a continuum from the average level of creativity to significant creative advance; it is possible for anyone with normal cognitive functioning to produce work that is creative to some extent within this continuum (McFadzean, 1998; Walling, 2009);

b) Degrees of creativity can be found within an individual's output (Amabile, 1996);

c) Where high levels of creative output occur often there is a match between the individual and the domain (Csiksentmihalyi, 1997);

d) Ages of creativity peak at different points within different domains (Simonton, 1975);

e) Creativity can be increased to an extent (Stein, 1974, 1975);

f) Talent, education, and cognitive skills alone cannot predict levels of creativity (Simonton, 1975);

g) Certain clusters of personality traits are consistent in those who are deemed creative (MacKinnon, 1965; Stein, 1974);

h) Many creative individuals have described a phenomenon known as "incubation" (Ellwood, Pallier, Snyder, & Gallate, 2009; Wallas, 1926); where one seeks rest from a problem prior to constructing its final solution; the diverging phenomenon of "flow" (Csiksentmihalyi, 1997) is a mental state in which an individual achieves deep levels of concentration where their emotions are positive, energized, and aligned with the task at hand;

i) Both an eagerness to work diligently and a mental playfulness are found in creative individuals (Csiksentmihalyi,1997; Golann, 1963); and,

j) Although extrinsic constraints can be detrimental to creativity, often individuals produce creative works under the constraints of identified motivation (Amabile, 1982, 1988, 1996; Cambell & Willis, 1978; Eisenberger & Selbst, 1994; Kasof, Chen, Himsel, & Greenberger, 2007)

Amabile's Componential Model of Creativity

Amabile's model brings together personality, cognition, and social factors in identifying components deemed necessary for creative production in a given field. This model builds a descriptive framework of how one may come to solutions during the creative process by addressing how the components contribute to a five-stage creative process model (1996). The model used was based upon earlier research models developed by Wallas (1926) and Hogath (1980). These stages include: Problem or Task Presentation, Preparation, Response Generation, Response Validation, and Outcome (Amabile, 1996). This model considered high and low levels of creativity. The first stage in Amabile's model, *Problem or Task Presentation*, is where the problem is either discovered or presented. Task motivation (intrinsic, as well as identified external motivation) is an important

influence on this stage as the creator would require high levels of motivation to accept the challenge of the problem. The second stage, *Preparation, is* where the creator uses or reactivates relevant knowledge to evaluate the problem. During this stage Domain Relevant skills are used. The third stage, *Response Generation, is* where the creator searches memory and environment to generate responses. Both motivation to continue the process and creativity-relevant skills would be utilized to explore cognitive pathways for problem seeking. A particular pathway is selected to pursue the problem. This stage is followed by *Response Validation* in which the creator tests the possible response against factual knowledge and established criteria. It is during this stage domain-relevant skills would be used to validate the response for correctness and appropriateness. The fifth and final stage is *Outcome,* in which the final solution must be judged. The creator has either accomplished the task, failed at the task and stops, or returns to previous steps and continues work. Task motivation would be required if the creator has failed and needs to return to previous steps in order to achieve continued progress. Work on a complex problem may contain several of these loops if task motivation is sufficiently high until the desired result is achieved.

The process model described above contains both divergent and convergent thinking skills. Guilford's (1950) classic distinction between convergent and divergent thinking is convergent thinking moves linearly toward a single solution, while divergent thinking moves associatively through multiple ideas. Domain relevant skills can be considered an example of divergent thinking as the creator sifts through previously recorded information in order to formulate a new idea.

Creative thinking skills contain primarily divergent thinking as well as convergent thinking skills. Examples of convergent production include problem finding, and response validation; whereas, divergent production includes data finding, and discovery of multiple solutions (Vail Sand, 2002).

An examination of Amabile's (1996) model revealed six general principles guiding creativity.

a) The higher the level of each component, the higher the level of creative output.

b) Domain-relevant skills primarily influence the appropriateness and the correctness of the proposed solution.

c) Creativity-relevant skills determine the novelty of the response.

d) Level and type of task motivation (intrinsic or extrinsic) determines whether the individual will engage and follow through with the task.

e) Process of task engagement is cyclical and future task motivation, often, hinges on successes in the current task.

f) Levels of task motivation can influence ensuing levels of domain-relevant and creativity-relevant skills. A high task motivation will increase the level of learning in both of the preceding components (Amabile, 1996).

The nomenclature of several terms in the model have been revised; Creativity-Relevant Skills has changed to "Creativity-Relevant Processes" to consider personality characteristics generally not measured as skills. "Communication" was added to "Response Validation" to signify work on a problem does not exist entirely within one's mind and ideas at some point need to be communicated to an external audience (Amabile, 1996).

In empirical testing of the model, the findings demonstrated when the three components were present higher levels of creativity exist (Conti, Koon, & Amabile,

1996; Eder & Sawyer, 2008). The original model has been expanded in Sternberg and Lubart's development of their Investment Theory of Creativity (1991, 1993), identifying six resources for creativity: intellectual processes or the ability to redefine problems, knowledge, intellectual style, personality, motivation, and environmental context; however, for the purposes of this research, investigation focuses on the initial three components of domain relevant skills, creativity-relevant skills, and motivation.

Domain relevant skills or domain experience. The creator, or the designer, makes use of domain relevant skills to both judge and synthesize new information. Domain experience includes technical skills and special talents as well as the application of inherent cognitive aptitudes, innate perceptual and motor skills, past experiences, and knowledge learned in the domain. Two distinct experiences contributing to domain experience in interior design can be identified as professional education and related experiences contributing knowledge about the design profession; and second, progressive experience obtained upon entering the profession. Talent, a component of domain experience refers to an individual's natural aptitude as special skills (Amabile, 1996). What is learned, where, and how information is stored makes an important distinction in level of creative production.

Exposure to a wide variety of knowledge enhances creativity. Leung and Chi-yue (2008) have suggested multicultural and other life experiences assist in the analysis of ideas and creative benefits. These results may depend on the extent to which an individual opens themselves up to new experiences within foreign cultures (Leung, Maddox, Galinsky, & Chi-yue, 2008). Bilingual children reinforce this

concept in scoring higher on verbal creativity tests than their counterparts (Okoh, 1980). Research findings have noted creative individuals hold different value systems than their less creative counterparts, with greater openness to experience, risk-taking and fostering change (Dollinger, Burke, & Gump, 2007; MacKinnon, 1962).

Wickelgren (1979) found that the more knowledge concentrated in specific areas and contexts, the less capacity one develops to learn general principles and perspectives outside specific domain realms, reinforcing the notion that too much specificity may result in decreased creativity. Research conducted on the relationship between knowledge and creativity reveals a paradox. Biographical accounts of composers, painters, and poets have formulated the *10 year rule* asserting it takes about a decade of intense study or practice to acquire world-class proficiency in a creative domain (Ericcson, Krampe, & Tesch-Romer, 1993; Hayes, 1989; Simon & Chase, 1973). High levels of deliberate practice and activities specifically designed to improve performance have shown to increase the proficiency of a given domain resulting in expertise (Ericsson & Charness, 1994).

Research has indicated extensive domain-specific knowledge as an antecedent to creative function, yet tension is introduced between knowledge and creativity (Sternberg, 1999). Research studies have indicated the relationship between knowledge and creativity suggests an inverted “U” (see Figure 1) Maximum creativity occurs in the middle range of knowledge acquisition; with too much knowledge limiting creative thinking (Simonton, 1984; Sternberg, 1999).

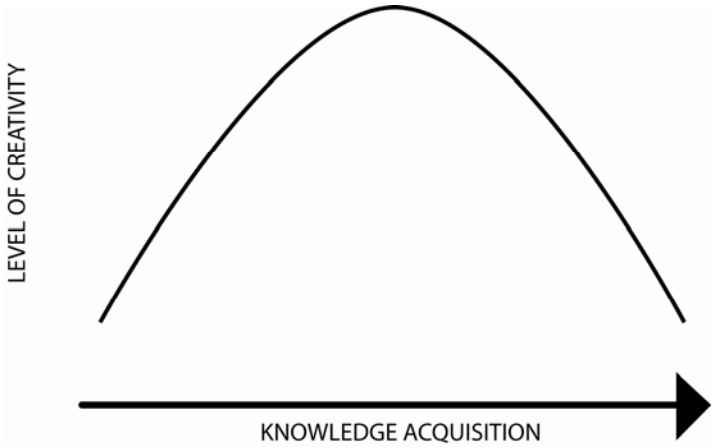

Figure 1. Diagram of inverted U: Relationship between knowledge and creativity.

Three sets of empirical findings (Simonton, 2000) discount assumptions that exceptional creators are merely extreme experts in their chosen domains:

a) Personality studies have shown that those who are considered creative often have different personality traits than those who are considered experts in their domain (Feist, 1998; Simonton, 2000, Sternberg & Lubart, 1995). In MacKinnon's (1965) study of eminent architects, he examined differences in personality and domain expertise; findings suggest eminent practitioners of architecture actualized their creative potentialities to a greater extent than those less eminent when compared from a self-recorded adjective checklist.

b) The development of domain-relevant experiences may differ for experts familiar with a specific body of knowledge to that of creators or individuals demonstrating a proficiency in creativity related actions (Simonton, 2000). Studies of the successes of 120 classical composers revealed that the most productive and eminent composers were engaged in music training for fewer years and composed for shorter times before making significant contributions to their fields (Simonton, 1991). Thus, concluding that the self-actualization personality traits in eminent individuals recorded by MacKinnon (1965) led to faster proficiency in a given domain.

c) The characteristics of creative careers in adulthood seem to be inconsistent with what might be predicted according to simple expertise-acquisition processes (Simonton, 1988). Creative productivity

> increases at the beginning of a career, and after attaining a peak subsequently has been demonstrated to decline (Simonton, 1984).

A basic level of domain knowledge is required to manifest some degree of creative output. Domain knowledge is used by the creator to first uncover the problem and then to thoroughly understand and analyze its parameters. However, once a level of proficient knowledge is achieved there is a point at which too much knowledge has been shown to have detrimental effects on creative output. Amabile (1996) counters this point suggesting domain knowledge, if organized effectively, minimizes the potential for detrimental effects on creative products.

Motivation. Early creativity research sought to answer the question "What drives creativity?" The consensus of these studies determined motivation or a passion for the task at hand as precursors to higher levels of creativity (Cox, 1926; Sternberg, 1999). Motivation determines an individual's approach to a task and includes both the individual's baseline attitude toward the problem and their perception and reasoning for undertaking a task. A direct relationship between motivational orientation brought to a task and likelihood of creativity found in the task was confirmed in empirical research (Amabile, 1983; Dollinger, Burke, & Gump, 2007; Hennessey, 2003). Task motivation depends on the initial level of intrinsic motivation toward the task, presence or absence of salient extrinsic constraints, and an individual's ability to cognitively minimize extrinsic constraints (Amabile, 1996).

Rogers (1954) suggested that creativity was motivated by a person's self-actualizing tendencies and the need to fulfill one's own personal potential. This left

room for the influence of external motivators, and distinguished between the roles of intrinsic and extrinsic motivation. Intrinsic motivation engages one to take on a task primarily because they find the problem interesting, stimulating, and satisfying; finding enjoyment in the work itself. Extrinsic motivation is distinguished by engaging in a task primarily to meet an outside goal i.e., reward or competition (Amabile, 1983). Differentiation of types of external motivators later identified by Kasof, Chen, Himsel, and Greenberger (2007). Theories surrounding the production of these higher levels of intrinsic and identified external motivation led to two distinct beliefs. The first, that creativity fulfilled a need for resolving psychological conflict (Abra, 1995; Klein, 1976) and the second, an opposing belief in which creativity fulfills a positive and healthy need to master one's own environment (Gedo, 1983; White, 1959). A twenty-five year study of highly creative women, underpinning the duality of motivation (Cangelosi & Schefer, 1992) revealed three psychological needs driving their creative activities: self-understanding, personal order and control, and emotional regulation. A majority of researchers agree that creativity is most likely to appear under intrinsic motivational states with extrinsic motivation as potentially detrimental to the process (Amabile, 1996; Amabile, DeJong, & Lepper, 1976; Csikszentmihalyi, 1996; Torrence, 1962). However, Deci and Ryan's (1991) depiction of extrinsic motivation differs to the degree that the creator attributes personal motivation externally (controlled motivation) versus internally (autonomous motivation), or identified motivation as pressure experienced, because one feels they *ought* to do something. In both concepts of motivation, the creator must be motivated and have commitment to an idea and needs to be immersed in the

creative problem. Paradoxically the creator also needs a sense of detachment to be able to separate oneself from the idea in order to fully view and rationally judge their own output (Henle, 1962; Kneller, 1965).

Intrinsic motivation occurs at differing levels dependent upon the challenge. Csikszentmihalyi (1996) noted higher levels of intrinsic motivation for discovered problems over those that were predetermined. Initial external motivators may be adequate to stimulate involvement in a problem and in turn serve to propel intrinsic motivation in order to continue with the task (Crutchfield, 1962). Research findings have also found that highly creative individuals accept challenge thereby becoming decidedly involved in complex problem solving activities (Albert, 1990). Learning-oriented individuals have further demonstrated a higher level of intrinsic motivation toward tasks than individuals with a lower learning orientation (Button, Mathieu, & Zajac, 1996). The devotion to a problem, or "flow" (Csikszentmihalyi, 1996) is a state of being where one is fully engaged in a problem relative to their level of skill and expertise. During this state, time ceases to exist thereby creating a high level of enjoyment in the task. It is when "flow" is achieved the highest levels of creative output can occur. Creativity may not only necessitate motivation but also generate it; this was suggested by the findings of a study where creative students were taught and assessed in a format that valued creativity. In the study, academic performance improved when students were taught using methods that balanced memory, analytical, practical, and creative thinking (Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996).

External motivation controversy. Studies have illustrated detrimental effects of external motivators (Amabile, 1982) but the issue of whether reward helps or hinders creativity remains controversial. Behavior modification studies have shown positive effects on creativity with the use of reward (Cambell & Willis, 1978; Eisenberger & Selbst, 1994). When participants were told how to be "creative" and then were rewarded for doing so, the level of creativity increased. Earlier research by Deci and Ryan (1985) indicated two types of extrinsic motivation - control and information - where extrinsic motivation is seen as controlling and at other times as informative, and even helpful to generating the solution. It has also been suggested that extrinsic motivation can co-exist with intrinsic motivation to benefit an individual in first initiating the quest for a solution and to keep the pursuit moving forward (Sternberg, 1988).

Motivation is an essential component for one to take on a complex task requiring a creative solution. The source for motivation can be extrinsic during the discovery of the problem or challenge, but early in the problem solving process the creator needs to manifest intrinsic motivation to pursue the problem beyond the initiation stage. The most creative people have been found to harbor higher levels of intrinsic motivation, frequently discovering their own problem(s) to solve (Csikszentmihalyi, 1996).

An observation from design practice exemplifies the role of motivation in a creative-oriented workplace: when designers have achieved the concept of "flow" (Csikszentmihalyi, 1996) they in turn dedicate long hours, at times "unpaid," to projects they find challenging and fulfilling. Designers engaged in creative work are

intrinsically motivated despite demands placed upon them. However, during economic lulls experienced in practice when projects may be more monotonous in nature and potentially less stimulating than creative-oriented assignments, a cultural shift has been observed to occur with less commitment to tasks considered mundane. Staff members are generally less concerned about getting the job done at all costs; and overall, appear to experience less commitment to their work environment.

Creativity relevant skills. Early tests of creative thinking capacity focused on an individual's level of divergent thinking; or the capacity to produce ideas that depart from the ordinary on the assumption that these ideas are indeed creative (Weisberg, 2006). Divergent thinking test required individuals to produce several responses to the same prompt with an emphasis on fluency or the number of ideas (Guilford, 1967; Torrance 1962). Guilford (1950) suggested that divergent thinking was one component to creative thinking along with convergent thinking, and the ability to evaluate ideas. Di Liello and Houghton (2008) described creative thinking skills as a range of capabilities ranging from the assessment of characteristics and personality traits of highly creative individuals to the measurement of creative products and achievements.

Creativity relevant skills, must be considered when examining the level of creativity. The use of creativity relevant skills, or synonymously, creative thinking skills, determines the extent to which a designer's product will surpass their predecessors. These skills depend on training, depth of experience in idea generation, and personality characteristics. Creative thinking skills include:

cognitive style or the ability to break down a problem; knowledge of heuristics, the ways to approach a problem; work style or the ability to concentrate and abandon unproductive strategies, diligence, and high work ethic (Amabile, 1996). These skills formulate the processes utilized in creative thinking.

Amabile (1996) defines creativity-relevant skills in terms of three elements. The first, cognitive style is: change in perception of a situation, keeping response options open and exploring new cognitive or thought pathways in understanding a problem's complexities. These skills might include the use of broad categories to organize information and identify relationships between diverse sets of information; an ability to remember accurately and be able to code, retain, and recall large amounts of detailed information; breaking out of performance sets; and, even simply perceiving creativity.

A second element of creativity-relevant skills is the knowledge of heuristics – a method of solving a problem for which no prescriptive formula exists. These processes are based on informal methods or experience, employing a form of trial and error. When used appropriately, shortcuts developed through creative thinking contribute to reduction of time and effort required in searching for a solution (Amabile, 1996). Theorists have proposed creativity heuristics to encompass:

a) "When all else fails try something counterintuitive" (Newell, Shaw, & Simon, 1962);

b) "Make the familiar strange" (Gordon, 1961);

c) Produce hypotheses by way of case study analysis and creation of analogies (McGuire, 1973); and,

d) Engage in "mental gymnastics" to play with ideas (Wickelgren, 1979).

A third element of creativity relevant skills is work style. The ideal work style includes several features (Amabile, 1996):

a) Capability for concentration and effort into an area for long periods of time (Campbell, 1960; Hogarth, 1980; Prentky, 1980);

b) Ability to discard unproductive investigations in problem solving (Simon, 1966);

c) Persistence in the face of adversity (Roe, 1953; Walberg, 1971); and,

d) High energy levels and strong work ethics (Simonton, 1980).

Some creativity-relevant skills can be taught through training but others are inherent to one's personality (Amabile, 1996).

The construct of creativity-relevant skills comprise intangible processes determining the outcome of a creative product. Cognitive style, knowledge of heuristics, and work style each contribute to the creative process to enhance design product; this is the differentiator between everyday creation and creative thinking representing a higher order of perception and cognition.

Components in the Creative Process

During the course of solving a design problem certain components are more useful than others. Task motivation is responsible for initiating and sustaining the process. Domain-relevant skills determine what analysis will occur during the process and ultimately what criteria the solution will be judged upon. Creativity relevant skills act as the "executive controller" during the process to influence the ways in which the individual will proceed (Amabile, 1996).

There is a cyclical nature relative to how the process will affect these components. Successful and failed outcomes can directly influence task motivation. High task motivation can increase learning; which, in-turn can heighten both domain-relevant and creativity-relevant skills (Amabile, 1996).

The three Components of Creativity - domain relevant skills, motivation and creative thinking skills - appear necessary to achieve high levels of creative output. After analysis it becomes apparent that motivation is an intangible infusion throughout the process. Motivation is not only needed to initiate the quest to solve a problem but also to continue the pursuit even if desired outcomes are not achieved. Domain experience is necessary during the initial or analysis stages of the creative process and again to a lesser degree when testing the problem. Domain knowledge is used by the creator to first find a problem and then uncover its components, and is typically utilized in more analysis driven activities. Creative thinking is the highest level of thinking, contributing to the synthesis phase of the process when ideas are being judged for level of novelness. Understanding how these three components interact in the creative process provides a foundation upon which to examine the creative process.

The Creative Design Process

The design process is a multifaceted and dynamic path of thinking required to execute a project in project-based disciplines including interior design and architecture. Psychologists and philosophers have studied phases of the creative process; however little comparative work has been conducted on the stages regarding taxonomy of analysis or synthesis among models. Ten seminal and

contemporary creative process models were considered for comparison to examine their similarities and differences regarding stages and cognitive processes. These models were selected for analysis to provide a representative and interdisciplinary view of the creative process spanning the origins of creativity to contemporary thinking about the design process. The selected models were grouped according to number of stages and used the transitional nexus between analysis and synthesis activities - the point of creation or idea generation - as a baseline to view the model's focus and contributions to creative thinking. The majority of stages reflected a focus emphasizing analysis. Analysis is the process of dissecting and analyzing a problem, and synthesis is the process of putting those parts together to formulate a solution (Kilmer & Kilmer, 1992). Visual analysis resulted in four distinct categories: simple, balanced, complex analysis, and complex synthesis.

For this comparison the constant was the transition point between analysis and synthesis or the stage of idea generation (see Figure 2). Between these activities is the stage when the creator generates multiple solutions to later edit. Creators have written about the appearance of the solution as the climax to the creative process. This climax is often recalled as sudden and self-certifying; the creator is convinced of the appropriateness of the idea even before it is tested (Csikszentmihalyi, 1996; Kneller, 1965). Feldman (1988) recounts a moment of insight as the "moment when things came together so forcefully and dramatically as to nearly knock me off my feet" (p. 271).

Mayer (1995) described this same insight, referencing psychological studies, as completing a scheme. Where creative problem solving involves figuring out how

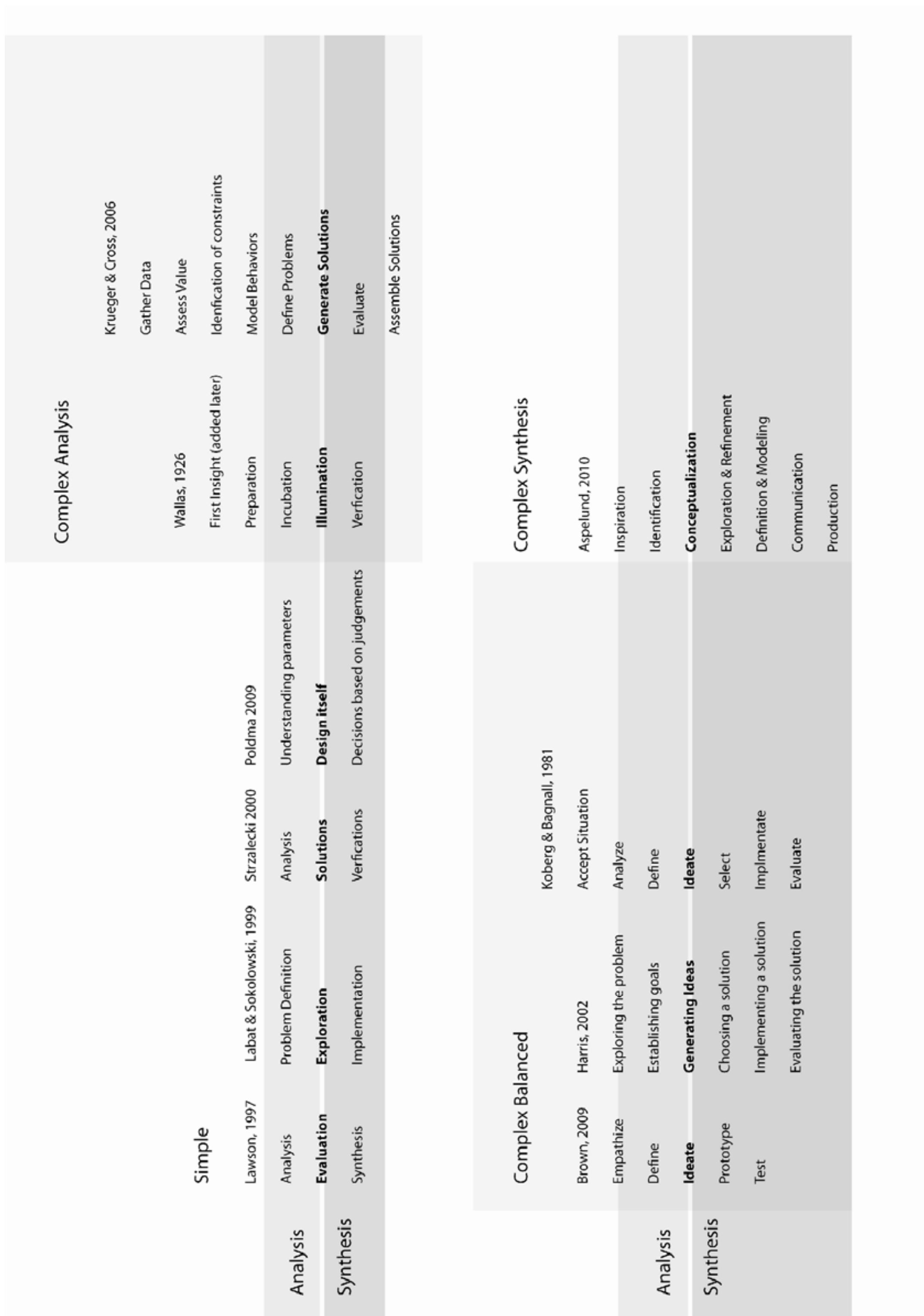

Figure 2. Comparison of creative process models within analysis-synthesis taxonomy.

the givens and the goal of a problem fit together within a coherent structure. Insight occurs when a problem-solver fills the gaps between analysis and solution. Insight triggered by visual data, as a sudden reorganization of thinking, occurs when the problem-solver looks at a problem in a different way. Insight can be considered as: reformulation of a problem, removing mental blocks, and finding a problem analogy where past experience can spark thought. It is the "aha" moment in the design process.

Simple process models. The most prevalent design process model identified was a model with three distinct phases of analysis, evaluation, and synthesis (Duerk, 1993; Lawson, 1997). This three-stage process model is commonly attributed to the design process maps developed by academics Markus (1969) and Mayer (1979). Their initial maps contained Analysis, Synthesis, Appraisal and Decision; and occurred during the proposal, schematic, and detail phase of an architectural commission. The ideation in their mapping transpired primarily in the schematic phase, with the detail phase encompassing production activities. These maps were subsequently distilled by Lawson (1997) into the three stages depicted today. The model is not sequential in nature but rather cyclical in that a designer may revisit any phase at any given time.

The three-stage models examined begin with a similar stage of analysis of the problem; involving the exploration of relationships, patterns, and objectives in existing available information (Lawson, 1997). It is during this phase that the problem is first identified. Lawson reaffirms the lack of a formal start or end point with activities in the synthesis phases revisited during any phase of the process. In

Lawson's model, evaluation is used to assess outcomes generated, and can occur, and reoccur at any point in the process.

The Labat and Solowski (1999) model is grounded in the discipline of textile product design. It was created after researchers examined the design processes derived from engineering, architecture, and industrial design. Typical steps could be sorted into three areas: Problem Definition and Research, Creative Exploration, and Implementation. This model retains similar themes to that of Lawson's (1997) with the first two stages incorporating investigation of the problem and actions taken to solve the problem; however, the Labat and Solowski model is more production oriented, taking the process further to a stage of implementation emphasizing production of goods.

The phase of problem definition and research is guided by potential constraints on time and budget, and cites a preliminary problem followed by a working definition or concept of the problem. Labat and Sokolowski (1999) next construct a phase of Creative Exploration. It is during this stage that as many ideas as possible are generated, and later constraints can be imposed to refine the products. It is not until after these refinements are introduced that investments in prototypes are made.

Labat and Sokolowski (1999) conclude the process with the stage of Implementation. During this stage, focus is narrowed to the reality of production. However, at the conclusion of this stage it may also be necessary to revert to earlier stages for further refinement.

The Strzalecki (2000) Problem Solving Model is a psychology-based model comprised of three phases: Analysis of the Problem, Solutions, and Verification of Solutions. The model was empirically tested using heuristic rules useful in problem solving and verification of the psychological traits associated with these rules. The three phases are dependent on ten independent psychological traits - strength of ego, tolerance of cognitive inconsistencies, spontaneity, flexibility of cognitive process, aesthetic attitude, self-realization, internal locus of evaluation, autonomous cognitive motivation, originality, and non-conformism. This model is similar to other three-stage models in that the first step is to understand the problem; the second is to attempt to solve it, and third to evaluate a solution.

Strzalecki begins the creative process with Analysis of the Problem, and during this phase of the designer's involvement styles of problem solving are utilized, i.e., active and systems attitude toward the problem, responsibility in looking at the problem, transgression or the ability to restructure the problem, objectivism as a rational attitude toward the problem, analogy seeking, ideal thinking, modular thinking or isolation of parts of the problem, intuitive thinking, independent thinking, conservatism in choosing easier ways to solve the problem, and finally, rationalism or cognitively grounded ways of looking at the problem at hand.

After problem identification, Strzalecki's model (2000) also progresses to a phase of generation of solutions. This phase contains styles of problem-solving including those similar to the second phase (i.e., responsibility, transgression, objectivism, analogy seeking, modular thinking, intuitive thinking, independent

thinking, conservatism) as well as new concepts encompassing an active attitude toward the problem, reductive thinking as the ability to reduce a problem to find familiar elements, openness, systems approach, and flexibility.

The final phase in Strzalecki's model (2000) is the Verification of Solutions; this phase includes the same concepts of generation (i.e., responsibility, transgression, objectivism, modular thinking, intuitive thinking, independent thinking, conservatism, an active attitude toward the problem, openness, systems approach, flexibility) and now includes persistence. These styles of problem solving include the psychological traits that would influence the processes of the creator during each phase of the creative process.

Poldma (2009) looked at the design process specifically from the discipline of interior design. The model resulted from survey data compiled documenting previously recorded design process models, as well as an analysis of drawings as the product of design thinking. Narrative accounts of typical steps taken during an interior design commission were also collected for analysis. From the findings, three primary elements of the process were developed and defined as concepts describing the creative thinking process. These concepts or stages comprise the interior design process model: understanding the parameters and questions of the design problem, design itself, and decisions based on judgments. This model also retains similar phases of previous models; first, understanding the problem; second, acting upon it; and third, evaluating solutions.

In Poldma's model (2009) the process begins with understanding the parameters and questions of the design problem, thereby immersing oneself in the

project and tasks. Tasks involved in this phase include: collecting and analyzing information.

The second concept of Poldma's (2009) design process is the design itself. During this stage the designers conceptualize an interior space using creative and technical techniques to develop and illustrate design ideas. Tools often used include: planning, sketching, and modeling; to better define the problem and explain what is appropriate within the context of the problem. Often a designer returns to the analysis phase to determine if potential solutions match the requirements of the problem.

Poldma's (2009) final stage is where decisions are made based upon critical judgments, and aspects of the design are decided based on merit. The interior designer chooses the best course of action based upon the outcome of their work. Designers then propose a final design or solution, and prepare detailed drawings of concepts to be constructed. Finalizing plans, elevations, and furniture; as well as communicating these ideas to others will be necessary to complete the documentation of the design.

These models are remarkably similar; each starting with a phase of analysis, when the parameters of the problem are initially understood. The process then moves into a generative stage, when the creator makes the first attempts to solve the problem that has been identified. The process concludes with a phase of judgment, when the designer seeks evaluation of the solution. What these models lack is a stage of reflection on the knowledge ascertained by the process. This added stage could help inform future endeavors.

Complex balanced process models. Three models represented more elaborative accounts of the design process than their three-stage counterparts. Yet, they retained a clear balance between the stages of analysis and synthesis; each from a different perspective. Brown's (2009) model emphasizes action-oriented steps and the importance of user perspective. This five-stage design thinking process model is the collaboration between Brown, the founder of IDEO, and the Institute of Design at Stanford commonly referred to as *d.school* (d.school, 2009). Brown, a well-known industrial designer, documented the cognitive strategy of *Design Thinking* in the popular press. Steps in this process include: Empathize, Define, Ideate, Prototype, and Test. What differentiates this model from many others is that it is typically used in a collaborative and group setting and focuses on human values by taking actionable steps (d.school, 2009).

Brown begins the process with two steps to identify the problem; the first, Empathize, where a designer observes human behavior and engages with those impacted by the outcome of the design. This is done to better understand and later define the problem in terms of behavioral change. By including the Empathize phase in the process, thoughts and values are revealed often not obvious to the people who hold them and with positive engagement unanticipated insights may be discovered. Additional goals in the empathize stage include uncovering needs of which people may not be aware, guiding innovation efforts, identifying who to design for, and discovering the emotions that guide behaviors (d.school, 2009).

The next step is to define the problem with an actionable problem statement. Here the designer begins to "focus" on the problem. A narrow problem statement is

needed to craft a solution. This statement provides focus and inspires the designer or team of designers, providing a reference point for evaluating ideas, allowing the designer or team to make decisions independently to fuel brainstorming (d.school, 2009).

The model includes a phase of Ideation, focusing on idea generation. In the previous phase the designer narrowly defined the problem using a problem statement; now the designer or team can go "wide" to include multiple ideas. Ideation can be used to get the obvious solutions worked out so that they then go beyond the obvious; to harness collective perspectives, uncover unexpected areas of exploration, and create both fluency (volume) and flexibility (variety) in solution options (d.school, 2009).

In the Prototyping phase the designer(s) will create anything that can be interacted with and used to assist in the design process, including notes, models, role-playing, and storyboards. These tools are to be created quickly and used to learn, solve disagreements, start conversations, test possibilities, fail quickly and cheaply, and identify smaller variables to test (d.school, 2009).

The phases of Idea Generation and Testing appear to be somewhat blurred as his process model attempts to include quick prototypes in the more generative phases. These prototypes do however lead toward more verifiable modes in the testing phase. Brown (2009) suggests "We should always prototype as if we know we're right, but test as if we know we're wrong—testing is the chance to refine our solutions and make them better." Testing helps designers to evaluate their solutions, learn more about the users, and refine the point of view of the user

(d.school, 2009). Brown's model is unique regarding its emphasis on the end-user's perspective.

The Problem Solving Model was documented by Harris (2002). This six-stage model is considered a step-by-step approach to be used by students when solving unstructured problems. The process is grounded in critical thinking and creative problem-solving and encourages the use of imagination and analysis. Harris begins the problem-solving cycle with Exploring the Problem. In this stage the designer states, clarifies, and then restates the problem while also representing the problem abstractly in philosophical terms to broaden the approach. The designer articulates their own assumptions to shape the way the problem will be advanced. Harris further noted the best problem solving abilities come from being able to achieve a mental reach-around the problem encompassing multiple viewpoints, alternate explanations, disconfirming evidence, and multiple viewpoints of attack; goals are used to clarify what the solution should look like.

As in previous models, the goal of generating ideas is to produce as many ideas as possible by of observing how similar problems have been solved, comparing the problem to a familiar situation, breaking the problem down into parts, brainstorming, or changing roles to develop a new approach to the problem.

Harris follows idea generation with Choosing a Solution. During this stage both intended and unintended consequences for each solution are evaluated followed by the choice of a solution. The process includes consequence analysis and selection; where solutions selected according to their effectiveness, efficiency, and simplicity. Once the solution is chosen, the process then moves to

implementing the solution; the result of the design must now be acceptable to all it involves. The solution may need further adjustment as it is implemented.

Harris's final stage, Evaluating the Solution considers the solution and its consequences upon implementation. Potentially, this process can lead to further changes to the solution or even beginning a completely new iteration (Harris, 2002). This model differs from Brown's (2009) by formalizing the selection of ideas within the generating phase and has more emphasis on a linear sequence of actions.

Created by Koberg and Bagnall (1981), two architecture professors, the Universal Traveler model provides a "logical and orderly systematic process employed to solve world-level problems". It uses the analogy of travel while guiding the users through a lay person account of Cybernetics. The stages or "Energy States" as Koberg and Bagnall define them include: Accept Situation, Analyze, Define, Ideate, Select, Implement, and Evaluate.

The Universal Traveler Model begins the process with a phase of Accepting the Situation. It is during this phase that the designer will state the initial intention and accept the problem at hand as a challenge. This is followed by a stage of analysis where the designer begins to better understand the problem, define the problem, and determine the main issues that surround it.

Koberg and Bagnall's (1981) model follows steps of problem definition with a stage entitled Ideate. It is during this stage the designer seeks all possible ways of realizing a "means to achieve the predetermined ends". Tasks in this phase can include outlining strategies to achieve objectives, listing options and alternatives, and uncovering potential paths and plans to resolve a problem.

The Universal Traveler Model concludes the design process with a phase entitled Select. In this phase the designer(s) must make crucial decisions and compare their ideas with the defined goals to determine the best path. This stage is followed by Implementation of the Idea, when the designer activates the idea. The process concludes with Evaluation when actions are compared with end results and the idea is examined for flaws and defects. This phase involves reviewing achievements, examining behavioral changes, reviewing actionism, and assigning value to the solution (Koberg & Bagnall, 1981).

The complex balanced models contain more stages than preceding models. Unprecedented stages are listed – an acceptance of the problem followed by a formalized stage of analysis, and finally a discrete stage defining the problem before Ideation takes place. These models begin to formalize a stage of reflection; however, they are reflecting only upon the merit of the solution and not evaluating how the success of the process itself can be used to aid other queries.

Complex analysis process models. One of the first and best documented design process models is that of Wallas in his book, *Art of Thought* (1926). His Model of Creative Process contained four recognizable stages: Preparation, Incubation, Illumination, and Verification. The phases as documented are independent, however are rarely distinct in experience. Today, the process model often includes a first step entitled, First Insight. This is where the creator first identifies that there is a problem and that it needs to be solved. This phase does not yet include inspiration, only a notion that something needs to be done about the

problem. Some exploration may take place in this phase although it isn't of the systematic nature and rigor that occurs in the following stage (Kneller, 1965).

The next stage, Preparation, is the creator's first attempt at methodical exploration and possible solution generation for the problem. This is where the creator often reads, discusses, collects, and explores answers; often weighing the strengths and weakness of possible solutions. A paradox occurs as often, in order to think creatively, one must first familiarize themselves with relevant works of others (Lubart, 2001). Some argue with performing this task, believing they work best in a phase of "happy ignorance" because they could easily be overwhelmed with the ideas of others (Wallas, 1926).

The period of conscious planning found in the Preparation stage is followed by an unconscious state entitled Incubation. It is during this phase that conscious and unconscious elements of inquiry are integrated (Orlet, 2008; Wallas, 1926). This is where the creator seeks rest and relief from the problem. The phase can either be long or short, and one can cycle between it and Preparation phase. This is often a dangerous and dispiriting phase, as the creator may lose sight of the initial goal(s); but Kneller (1965) argues that this phase must take place in order to move forward to the next phase of the process. "Incubation requires both intense, focused intellectual work and great personal interest in attempting to solve a complex problem with the conscious temporary abandonment the specific problem" (Orlet, 2008).

Following incubation, the creator is rewarded with ideas in the Illumination stage. This is the most often written about stage and the climax to the process.

This occurs when the creator finds they have a sudden appearance of a solution, a "Eureka moment" where everything falls into place (Wallas, 1926).

The final phase of the process is Verification, when the creator can now synthesize and validate the raw material or ideas they created during the Illumination stage. These tasks may sometimes last for years as it may become a period of intense validation and arduous revisions. This phase may also lead to further insights and often the process begins again (Wallas, 1926).

Kneller (1965) also suggests there are certain conditions that normally must be achieved for these stages to occur. The creator must first be receptive to ideas as they cannot be forced; the creator must immerse themselves allowing approach to a problem from a range of sources and viewpoints. The creator also needs imagination to produce ideas and judgment to ultimately communicate them. They then need an ability to take a fresh look at what is typically taken for granted, and be able to constructively use errors. Finally, the creator needs to have submission to the work of the creative; meaning at some point the creative product will take a life of its own and illuminate its own needs (Kneller, 1965, p. 47-61).

Wallas' (1926) model has been empirically tested in "think aloud" studies of poets, visual artist, scientist, and laypeople when asked to create a product in their respective domains (Lubart, 2001). It was modified in 1965 by Kneller, an educational theorist, by adding the step of First Insights to the process.

In addition to Kneller's revision, several authors have suggested changes to early stages of the model citing that it is important to distinguish a problem-finding or problem forming phase from the preparatory phase in which relevant information

is gathered and preliminary ideas are advanced (Amabile, 1996; Getzels & Csikszentmihalyi, 1976).

The Expertise Model is a conceptual problem solving model based in the field of industrial design. It was created in 1999, by Krueger, to document the cognitive strategies utilized by nine experienced industrial designers during a given product design process. The model was based on empirical data obtained from protocol studies which was then analyzed with the aid of the CommonKADS conceptual modeling language (Krueger & Cross, 2006).

The Expertise model includes several steps in the preparation period. These steps include: gathering relevant data, assessing the value and validity of this data, followed by an examination of constraints and requirements of the problem at hand (Krueger &Cross, 2006). Similar to Brown's (2009) process, the Expertise Model includes steps of modeling behaviors and environments. These models assist designers in idea generation. The designer then generates partial solutions; these solutions are tested in later phases (Krueger & Cross, 2006). The designer ends the process by evaluating these solutions and finally assembling one coherent solution (Krueger & Cross, 2006).

In order to perform the analysis involved in this model, Krueger and Cross took additional steps in assessing the value of gathered information and modeling behaviors to define the problem. These elaborative analysis tasks led to the generation of a solution that will, again, be evaluated.

Complex synthesis process models. During the review of process models one surfaced delineating added stages occurring after idea generation. The staged

process by Aspelund (2010), a design professor, is rooted in fashion design but is conceived for use in design-related disciplines. It is considered to be a clearly delineated path, containing steps of Inspiration, Identification, Conceptualization, Exploration & Refinement, Definition and Modeling, Communication and finally, Production.

Asplelund (2010) begins the creative process with Inspiration. Inspiration gives the designer motivation and can come from many sources. Aspelund follows Inspiration with a stage of Identification. In the Identification stage the designer needs to identify what the design needs and define the limits.

The model follows Identification with Conceptualization, where the designer now begins to attempt tangible solutions to the problem. Several tools can be used to aid the process including brainstorming, Gestalt perception, analogies, metaphors, similes, and intuitive thinking. At the end of Conceptualization, the designer should be able to answer questions describing and explaining the design to others, and be able perceive whether or not their concept is good.

Aspelund (2010) follows the Conceptualization stage with a stage of Exploration/Refinement where the design concept is further examined and tested to "its limits." All unexplored possibilities need to be tested despite possible outcomes. This stage is more focused and solution-oriented than previous stages. This stage cannot be rushed, and is aimed at testing the viability of the design concept. The next stage, Definition/Modeling, is more detail orientated, and is where concept now becomes a tangible object. Aspelund (2010) suggests this is the most difficult

stage for a designer to complete as it is during this stage that the designer now must commit to one concept, thereby excluding all other possibilities.

Aspelund (2010) follows the Definition/Modeling stage with a stage of Communication where the designer now must convey his or her idea to different audiences. This stage is followed by Production where the design is prototyped and decisions are further examined against real world factors including budgets, schedules, materials, and sustainability.

The Aspelund (2010) model is uniquely situated along the continuum; it reverses the archetypal order between conceptualization and exploration. Conceptualization is earlier in the process and Exploration/Refinement is used as a tool to explore any remaining unexplored thought pathways. The model is also more solution-oriented and includes more stages in synthesis, to allow for the modeling and communication of a design idea. Reflection is not a formal stage in the process; however, Aspelund does informally mention that every project is a learning experience and can be used to fuel oneself for the next project.

Reflection

The examined models listed reflection as a component to the process to varying degrees; thus, inviting further research on its usage. Epstein (2000) describes a creative lifestyle as essential to achieving high levels of creative output. To do so he list four basic tenets, one of which is to make omnipresent use of journaling and other recording devices to capture creative thoughts and preserve new ideas. These reflections can be used not only to jump start new ventures but to self-assess and enhance the level of future endeavors.

Hutchings and Wutzdoff (1988) defined reflection as an ability to ponder one's own experience and abstract from it some meaning or knowledge which is relevant to other experiences. Boud (2001, p. 2) stated reflective journal writing can be used to enhance creativity by "making better use of intuitive understanding".

> Reflection involves taking the unprocessed, raw material of experience and engaging with it as a way to make sense of what has occurred. It involves exploring often messy and confused events and focusing on the thoughts and emotions that accompany them (Boud, 2001, p. 2).

Proposed Creative Process Model

Despite the number of stages, many commonalities were uncovered during the course of the model review. All processes included a form of analysis, conceptualization, and synthesis. Each model could be distilled into several stages with differing sub-processes. Some models started with a precursory step of problem seeking. This typically occurred when an intrinsically motivated creator would seek his or her own problem to be solved. However, after a problem was uncovered or given, all models typically analyzed the problem to understand constraints and parameters. Next, a phase of generation occurred with a goal of creating as many possible outcomes and solutions to the problem as possible. Following generation, typically a phase of synthesis or testing to understand if the solution was valid was undertaken (e.g., prototyping, modeling) Few models included stages of reflection; either casually mentioning reflection at the end of the process or as a precursor to the return to previous phases. No discussion was directed toward how reflection in the process could contribute to more successful design products.

The review of models and process by diverse researchers formed the framework for a Proposed Model of Creative Process (Figure 3).

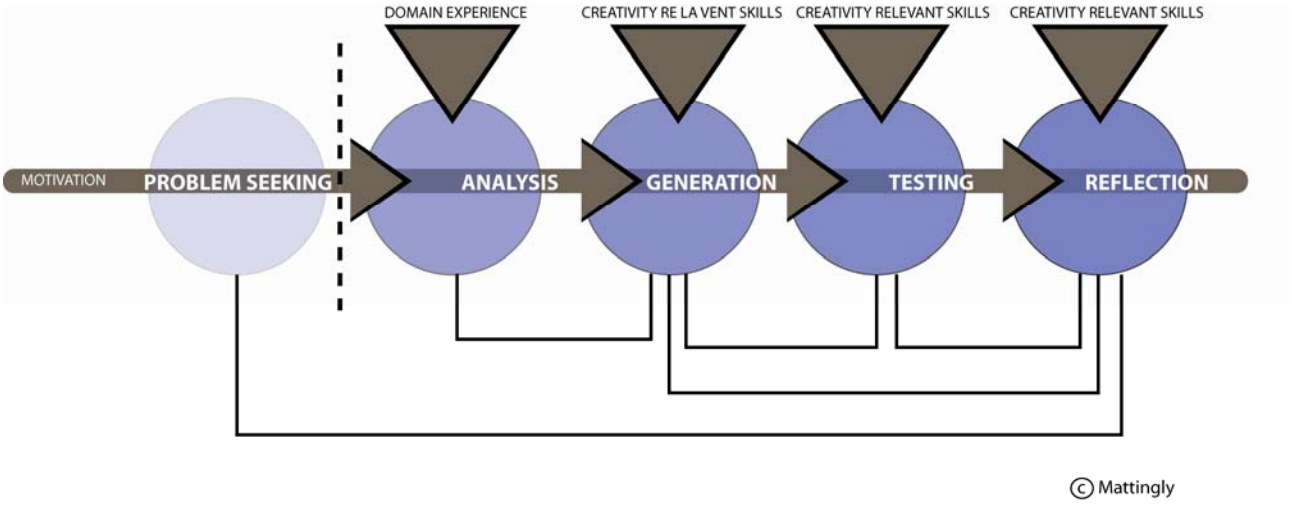

Figure 3. Proposed creative process model (Mattingly, 2010).

This model includes both stages in the process, and contributions from the Components of Creativity (Amabile, 1996) within each stage.

The stages in the process include: Problem Seeking, Analysis, Generation, Testing, and Reflection. These steps are not linear, as feedback and other influences can invite the designer to return to previous phases.

The process begins with a Problem Seeking phase. This stage occurs when highly motivated individuals find their own problems to solve through life experience or experimentation, but may also occur when an assigned problem is re-shaped by the creator. The stage does not, however, always occur in the process if the design problem is initiated and the parameters overly controlled, precluding creativity.

The stage of Analysis, when the designer seeks to better understand the problem, its parameters, and constraints, can be accomplished through research, seeking precedent designs, or relevant observational studies. Domain expertise

would be required in this phase for the designer to have the ability to compare the current problem with previous occurrences and solutions, and even to comprehend if they are attempting to solve the correct problem.

Generation, the next stage, is when the designer first acquires ideas to solve the problem. These solutions aren't yet filtered or judged and often many potential solutions arise. Creativity relevant skills contribute to this stage in generating with the most potential solutions (fluency). Judgment is temporarily restrained and solutions can be conceptualized through the use of numerous types of media.

Testing, when the designer judges or tests the solutions previously generated can include: prototyping, role-playing, and modeling. Creativity relevant skills are utilized to critically analyze the solutions for their novelness.

The process concludes with a phase of Reflection in which the designer uses previous experiences to judge the final product and conclude work on the design is successful, or revisit previous phases to improve the design. The reflective task can be used to inform future design endeavors and assist designers in creation of valuable heuristics.

In this proposed model, motivation is threaded throughout the process differing from Amablie's (1996) Componential Framework for Creativity, where task motivation is thought to enhance domain and creativity relevant skills; used at different phases during the process. In this model, it is assumed in addition to increasing domain and creativity relevant skills, motivation is still necessary during each stage to keep the creator focused and working on the problem at hand. As a theoretical model, testing, and exploration of each phase invites empirical inquiry.

The expectation of the study is that participants will utilize the proposed stages of this proposed model during their process of design and utilize Amabile's (1996) Components of Creativity to the greatest extent during the stages indicated (see Figure 3).

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

This research exploration sought to examine the subjective experiences, processes, and actions taken by a cohort of fourth year interior design students during a two-week design project. As a qualitative study employing an explorative case study framework (Creswell, 2009; Stake, 1995), data was collected from student records, reflective journal narratives responding to pre-determined electronic prompts by the researcher, and an external evaluation of the final outcome of the process, a scale model of a chair and accompanying design process board.

Participants were asked to answer specific questioning prompts as they developed their solution to the problem. These prompts were delivered during four interventions within 90 minutes of the conclusion of four studio class periods during the design project. The questions focused on reflection of their experiences during their creative process and the sequence of their actions as they worked through the project challenge. Reflective journaling was used to record personal experiences that cannot be quantified into facts and statistic data (Clandin & Connelly, 2000). Journal narratives were inspected for themes and patterns of problem solving and critical activities utilizing a deductive process based upon the study's proposed

model. Template analysis (Crabtree & Miller, 1999) was used to predetermine key words expected to be relevant to the data.

The study sought evidence to support the proposed process model derived from analysis of the 10 selected models and confirm presence of Amabile's (1996) three Components of Creativity – domain relevant skills, creativity relevant skills, and motivation. The study also sought to determine distinctions in processes of highly creative and less creative participants.

Study Population

The Council for Interior Design Accreditation (CIDA) accredits professional programs of interior design. Since the inception of the accreditation process 40 years ago, roughly 200 programs have been accredited. The accreditation process is an outcome based procedure evaluating preparation of entry level professionals with a comparable skill foundation across accredited programs. Despite the individuality of each program's path of preparation and discipline home (e.g., art, architecture, human ecology) this accreditation process provides a degree of commonality regarding specific discipline knowledge of entry level interior designers graduating from four and five year bachelor's level degree programs. Examination of one accredited university program in interior design at the culmination of graduating year has the potential to reflect characteristics of graduates across CIDA accredited programs; at minimum, cohorts from land grant higher education institutions are reflected.

The target sample for this study is a census (Patten, 2009) comprised of all students in their fourth year of study in interior design program at Colorado State

University, accredited by CIDA for over twenty years. The class roster was used to invite students to participate and consent to be included in the study. By consenting to participate, students agreed to have their work externally evaluated and to allow access to their student records. Since the capstone course is a two semester sequence, enrollment continued into the spring semester; and data from the project could be accessed after the fall semester. Thirty-six female students comprise the course participants in this 400 level studio with an average age in the early to mid-20s

Data Collection

All students received from the instructor, as a regular component of the course, an introduction and overview to the project encompassing the scope, project requirements, schedule, requirements for the construction of the scale model, and a description of the reflective journaling. Students were to respond to question prompts within 24 hours of each class day of the project (4 interventions). The participants were familiar with journaling and reflection from a previous project when it was a component of a five-week long, service-learning, team-based project. The journaling exercise was a component of the graded assessment; however, only journal entries of students who both agreed to participate (see Appendix A) and responded within the allotted time were included in the data set.

The instructor received a project script to read verbatim to announce the project. All students were then provided with a copy of the project sheet (see Appendix B) to introduce the design problem. Each student also received a copy of the Letter of Consent (see Appendix A) accompanied by a verbal description of the

research study which would be carried out at the conclusion of the semester. Students could choose to participate in the study by signing, and submitting the informed consent letters. Students had several weeks to make their decision to participate; signed consents for those agreeing to participate were submitted to the researcher. Demographic data, and prompts responding to the questions (see Appendix C) were collected following receiving signatures.

The protocol for this study was reviewed by the Research Integrity and Compliance Review Office's Institutional Review Board (IRB) at Colorado State University and determined to be in compliance with NIH CFR 46 and the federal regulations governing review of research involving human subjects (see Appendix D).

Data Analysis

To date few models study the presence of creativity and its components during the process of designing creative products. To determine the sequence of actions taken, and confirm presence of the components of creativity three sources of data were analyzed: student demographic information, individual student reflections, and project outcomes.

Student Demographic Information

Domain relevant skills were accessed by the researcher using student academic records to determine credit and transfer hours taken, and types of external experiences related to design including credit hours for internships, and study abroad experiences.

Individual Student Reflections

Journal entries were examined using a deductive process to ascertain process steps and sequence of activities taken by students during the design assignment. The students were asked to respond to open-ended questions (see Appendix C) evaluating their design progress, ongoing and completed tasks and activities, and the affirmation of Amabile's (1996) Components of Creativity.

Journal entries were analyzed and prepared for analysis using qualitative software (QSR NVivo v.9). Using template analysis, data were coded according to relevant *a priori themes* (Crabtree & Miller, 1999). Keywords were developed to ascertain participant's task involvement. Nodes were developed according to the predetermined codes (See Table 1) and key words associated with discrete stages of the proposed study model. The construct of motivation was qualified using keywords from response prompts eliciting level of "interest in the task", and level of "excitement to continue" with the project.

Table 1
Qualitative Coding Template for Participant Journal Entries

Entry 1	**Entry 2**	**Entry 3**	**Entry 4 (recalled data)**
Motivation	Motivation	Motivation	Motivation
Analysis Task	Analysis Task	Analysis Task	Analysis Task
Generation Task	Generation Task	Generation Task	Generation Task
Testing Task	Testing Task	Testing Task	Testing Task
Reflection Task	Reflection Task	Reflection Task	Reflection Task

The researcher tested the proposed model by examining tasks outlined by each participant during time sensitive entries (the 24-hour window given to respond to the question prompt). Key words indicating task involvement were recorded; and were used to determine in which phase the participant was engaged during each consecutive entry (see Figure 4). Tasks including 'research and criteria review' were considered *Analysis.* Tasks such as 'sketching and designing' were grouped in the *Generative stage. Testing* included task such as experimentation or prototyping, and descriptions including 'reviewing or reflecting' were grouped in the *Reflection* stage.

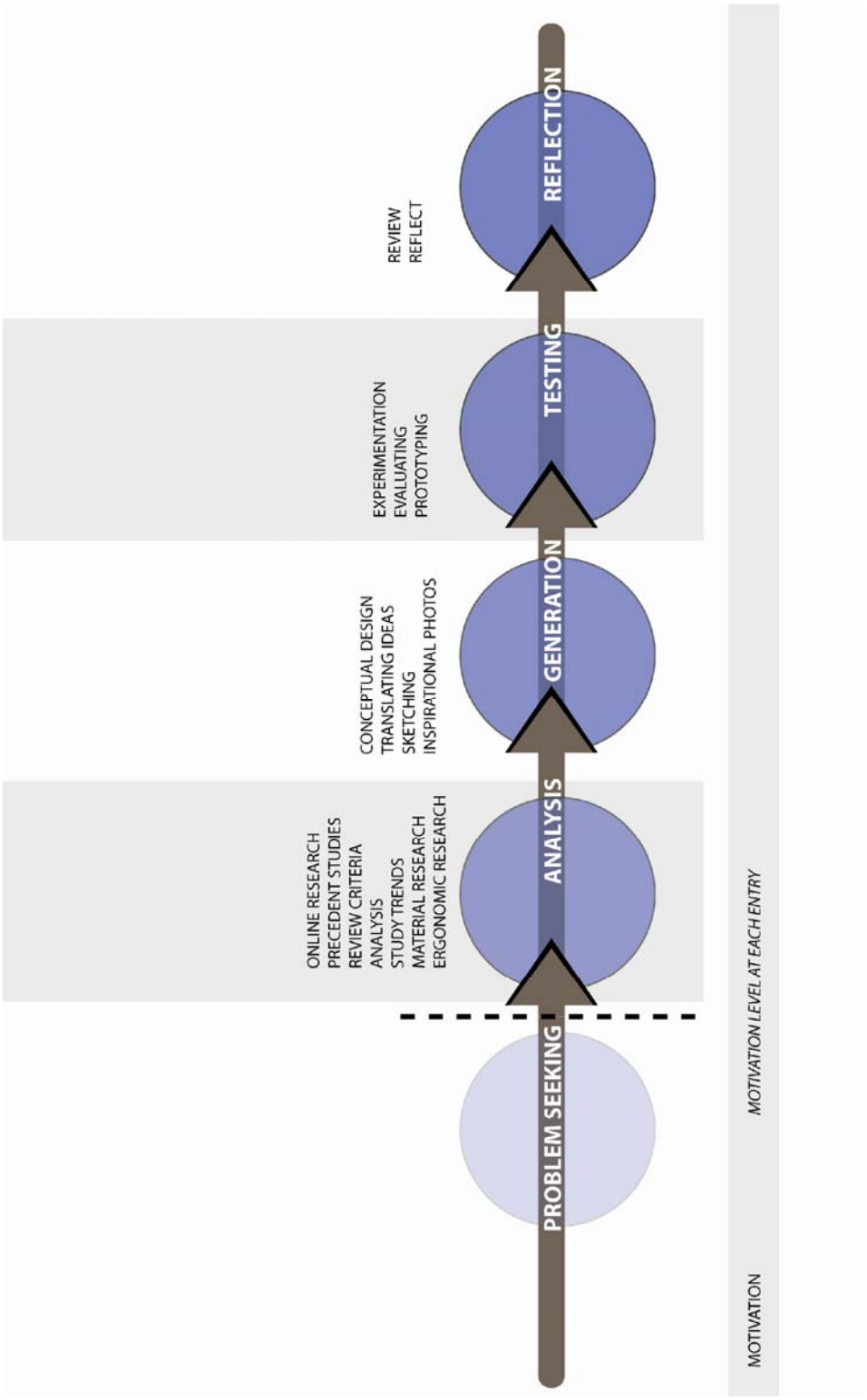

Figure 4. Qualitative coding process diagram with task and activity keywords assigned to each process stage.

To test the proposed design process model for task common among participants, the researcher counted frequency of keywords used. This was done by creating codes outlining the task and counting frequency of occurrence found within prompt responses 1-3 (Creswell, 2009).

Following analysis using the predetermined codes, open codes added richness to the coding process. This coding included responses on use of research, expanded evidence of domain experience, levels of frustration and frustration mediating techniques, specific comments referring to unique qualities of their process, and if the students would continue work if more time was available.

Project Outcomes

Project outcomes, (e.g., scale model of the chair and accompanying design process boards) were analyzed according to the definition of creativity by two external evaluators with backgrounds in fine art and sociology teaching in interior design. Evaluators were asked to independently rate two distinct criteria - the level of novelness and the level of appropriateness--found within each solution based upon a 5-point Likert scale (“low” = 1; “high” = 5). The two criteria had five possible points or ten points total per evaluator with a total of 20 points possible for the overall assessment (see Appendix E). Final summated scores were used to identify two distinct groups by high and low creativity. Following this evaluation, the researcher compared process keywords and stages of each cohort to determine both commonalities and outliers in process and demographic data.

A coded list was used to maintain student anonymity and to identify participants after demographic data was collected and matched to projects, journal responses, and project outcomes evaluations.

Reliability

Consistency in the data was confirmed by checking transcripts for obvious mistakes. The researcher used constant comparative analysis to help ensure against minimal drifts in codes. Memos were created to guide the interpretation process, and comparison was done of coding by cross-checking with another researcher (Creswell, 2009, pp. 190-193).

Validity

Accuracy in the data was assessed using several strategies:

a) Use of keywords derived from participant's thick, rich, descriptions to fully account for experiences.

b) Clarification of researcher and instructor bias.

c) Attempt to control for bias created by similar experience and input; the assignment was a new project type for the students.

d) Students received limited influence from the studio professor; she read project description verbatim.

e) Project was conceived as an individual challenge to eliminate team problem solving.

f) The study was conducted over a short time frame to minimize opportunity for instructor and peer review or intervention and interpretation based upon the researcher's own design expertise.

g) Themes running contrary to researcher's assumptions were included, and elaborated on in the findings (Creswell, 2009, pp. 191-192).

CHAPTER IV

FINDINGS AND DISCUSSION

Data was collected from student records, journal entries, and external evaluations resulting in a mean data set as well as high and low creative data sets.

Participant Profile

Of 36 students enrolled in the course, 20 students both signed a letter of consent and completed each of the four journaling prompts within the required 24 hours provided for each intervention. Only participants who submitted within the 24 hour time frame for all four interventions were included. Timing of responses was important as participants who submitted their responses later had more time to reflect upon their entries or were possibly in later stages of the process; either scenario could potentially skew findings. All participants were in their fourth year of interior design studies within the Colorado State University CIDA accredited program, and had completed a range of 102 to 233 undergraduate credit hours (120 credit hour are required for graduation in the program). Students were female and ranged in age from 21 to 36 years. All but one student claimed Colorado residency. GPAs ranged from 2.99 to 3.85. Thirteen students had nine or more transfer credits from other colleges and five had study abroad experience.

Table 2 suggests a difference in GPA and transfer credits between the top and bottom third of participants. The data reveals a relationship between high total and transfer credit hours to higher GPAs. No significant relationship between age and GPA was revealed.

Table 2
Mean Student Profile: GPA, Age, Transfer and Total Credit Hours of Participants

GPA %	GPA	Age	Transfer Credits	Total Credits
Class Mean	3.49	22.85	26	139
Top 1/3	3.84	23.66	46	151.6
Middle 1/3	3.59	21.85	12.85	123.7
Bottom 1/3	3.10	23.14	14	124

Individual Student Reflections

Journal entries were examined using a deductive process with qualitative software (QSR NVivo v.9) to ascertain process steps and sequence of activities taken by students during the design assignment. The students were asked to respond to open-ended questions (see Appendix C) evaluating their design progress, ongoing and completed tasks and activities, and the affirmation of Amablie's (1996) Components of Creativity. Using template analysis data were coded according to relevant *a priori themes* (Crabtree & Miller, 1999) followed by the development of keywords depicting participant's specific task involvement. Nodes were developed according to these predetermined codes (See Table 1); Key

words signified discrete stages in the proposed study model. The construct of motivation was explored using keywords eliciting levels of “interest in the task”, and “excitement to continue” with the project.

Entry 1

A visual examination of the frequency of task illustrated that during the first intervention (completed within 24 hours of receiving the assignment statement) the majority of students (*n* = 19) indicated participation in task or activities associated with the *Analysis* stage of the process (i.e. research, investigation) and (*n* = 6) participants were indicated task associated with the *Generative* stage of the process (i.e. drawing, sketching). The analysis and generative task could be embarked upon concurrently or consecutively. No students mentioned any tasks associated with *Problem Seeking, Testing*, or *Reflection*. At this intervention students were asked about their level of interest in the project. Those that responded with “very interested” or similar responses were considered to have high levels of motivation, (*n* = 18), those who indicated medium levels of motivation or high levels of motivation with explicitly noted reservations were considered to have medium levels of motivation (*n* = 2).

Entry 2

During the second intervention (completed between 72 and 96 hours after receiving the assignment statement) the majority of students (*n* = 14) indicated participation in tasks and activities most closely associated with the *Generative* stage of the process, while (*n* = 6) remained active in the *Analysis* related tasks. Some students (*n* = 7) were participating in task associated with *Testing* their

solutions (i.e. product evaluation, prototyping). When asked how they felt about the work they had completed and how excited they were to move to the next stage of process student who responded with terms of “very good” and “very excited” or similar were considered to have high levels of motivation (*n* = 16), students who responded with terms of “fairly good” or “pretty excited” were considered to have medium levels of motivation (*n* = 2), and those who responded with statements indicating frustration with their current levels of production and quality of work or “not very interested” in moving on to the stage of the process were considered to have low levels of motivation (*n* = 2).

Entry 3

During the third intervention (completed between 144 and 192 hours after received the assignment statement) fewer students listed any task or activities in which they were involved. Nearly half the respondents (*n* = 8) suggested that they had already completed the assignment. At this intervention (*n* = 1) student responded with a task associated with the *Analysis* stage; (*n* = 3) students responded with a task in the *Generative* stage, and (*n* = 4) students responded with task associated with the *Testing* stage. When asked about their level of motivation students at this intervention who responded with statements of “very excited” or similar were consider to have high levels of motivation (*n* = 12), student who had completed the assignments or had mentioned statements that they were excited to be finished with the project were considered neutral regarding level of motivation (*n* = 8).

Entry 4

The fourth and final intervention was conducted at the close of the project after students had turned in their assignments. Questions asked during this intervention were reflective in nature utilizing remembered experiences. This data were used later in the analysis of determining differences between the high and low creativity groups. Move the entry diagram so that it is centered!

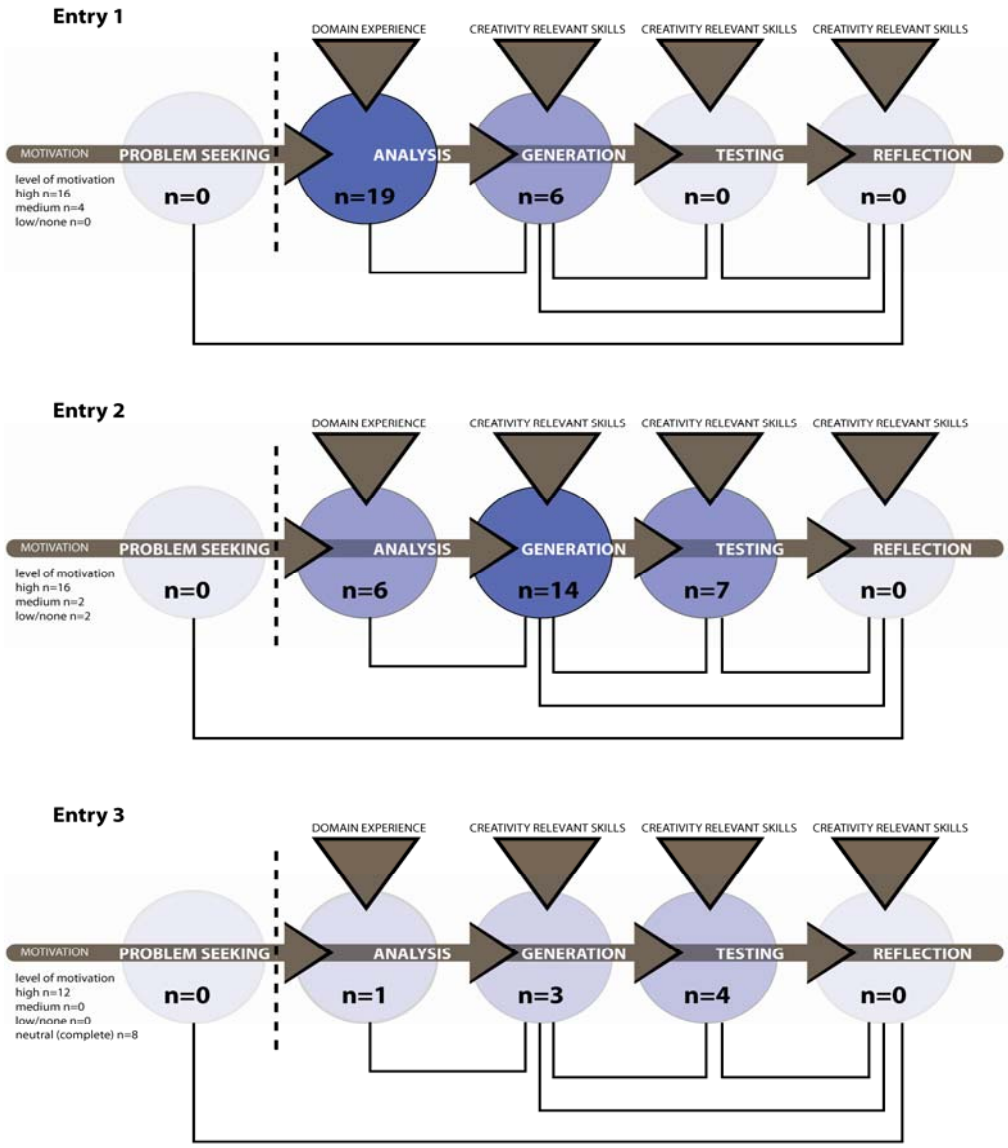

Figure 5. Frequency of task responses within process stage.

Challenges and Confirmations to the Proposed Process Model

The evaluative comparison of frequency of task responses during the first three consecutive entries confirmed the presence and relative placement of the *Analysis* and *Generative* stages in the proposed process. However, due to the scope of the project, or possibly time and workload constraints *Problem Seeking, Testing, and Reflective* stages were not be validated by the activities of participants in this study.

Project Assignment Outcomes

Following the analysis of participant's journals, the two external evaluators were asked to assess product outcomes for participants relative to degree of novelness and appropriateness for the project assignment (see Appendix E). Products were rated on a 5-point Likert scale for each of the two criteria resulting in 10 possible points per evaluator or 20 possible points total. All products were situated along a spectrum of creativity based upon their final scores. Six individuals had scores of 15 or higher (the highest number of points awarded was 18) and five individuals had scores of 11 or lower (the lowest number of points awarded was 9). The group of participants with scores of 15 or higher was designated as the high creativity group and participants with scores of 11 or lower comprised the low creativity group.

A statistical comparison of the groups illustrated several differences between the two groups of students (see Table 3).

Table 3
Group comparison on creativity, age, GPA, and credits.

Cohort	Age	GPA	Transfer Credits	Total Credits
High Creative	23.6	3.83	46	152
Low Creative	23	3.29	21.2	127.4

Participants deemed as "*highly creative*" had higher GPAs, as well as a greater number of transfer and total credit hours. This may indicate a relationship between creative output and success in assessments related to coursework requiring creative skills or creative thinking (i.e. interior design). Students with broad experiences (i.e. transfer credit hours) achieved relatively high creative output and students with increased domain experiences (i.e. college-level credit hours) achieved higher levels of creative output. Following the demographic evaluation the researcher examined the process of the participants in the high creative output cohort (n = 6) compared to those in the low creative output cohort (n = 5). This was done by measuring the frequency of task during each entry. Findings indicated that both cohorts followed similar sequence of task (see Figure 6).

Following evaluation of the demographic data, the process of the participants in the high creative group ($n = 6$) were compared to those in the low creativity group ($n = 5$) in terms of frequency of task involvement indicated during each entry (see Figure 6). For entry 1 all students in high and low creativity groups began the

assignment with tasks associated with *Analysis* (*n* = 6, high creativity group and *n* = 5, low creativity group); five described tasks associated with the *Generative* stage (*n* = 3, and *n* = 2, respectively). At entry 2, individuals participated in tasks associated with *Analysis, Generation, and Testing* at similar frequencies (*Analysis, n* = 2; *Generation*, *n* = 3; *Testing*, *n* = 2; high creativity group; *Analysis, n* = 2; *Generation*, *n* = 2; *Testing*, *n* = 3; low creativity group). At entry 3 a majority of individuals were undertaking tasks associated with *Testing* (*n* = 4; high creativity group; *n* = 3; low creativity group). Levels of motivation were similar between groups; both indicating excitement for the new project type.

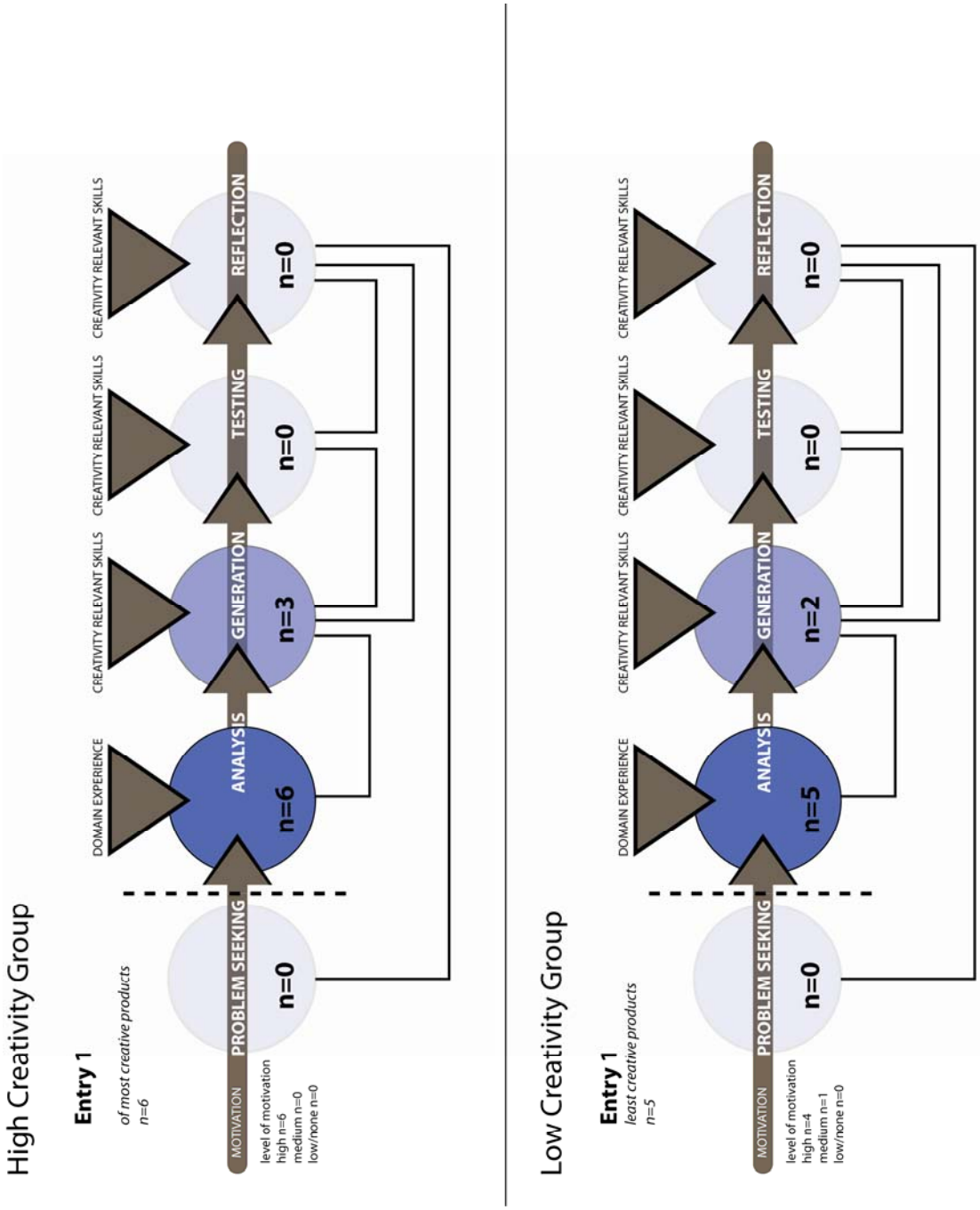

Figure 6.1. Entry 1: Comparison of process steps between high and low creativity groups.

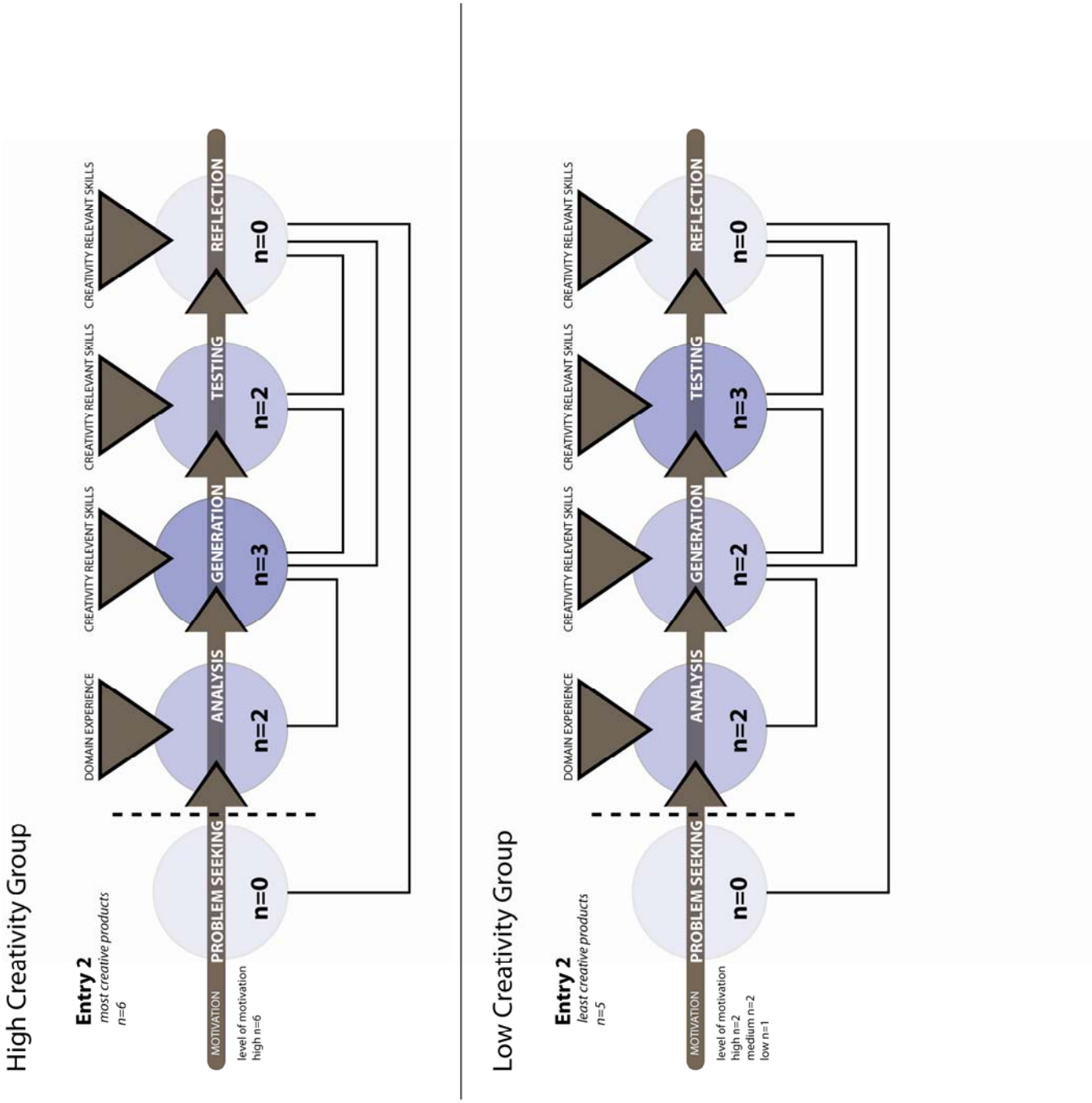

Figure 6.2. Entry 2: Comparison of process steps between high and low creativity groups.

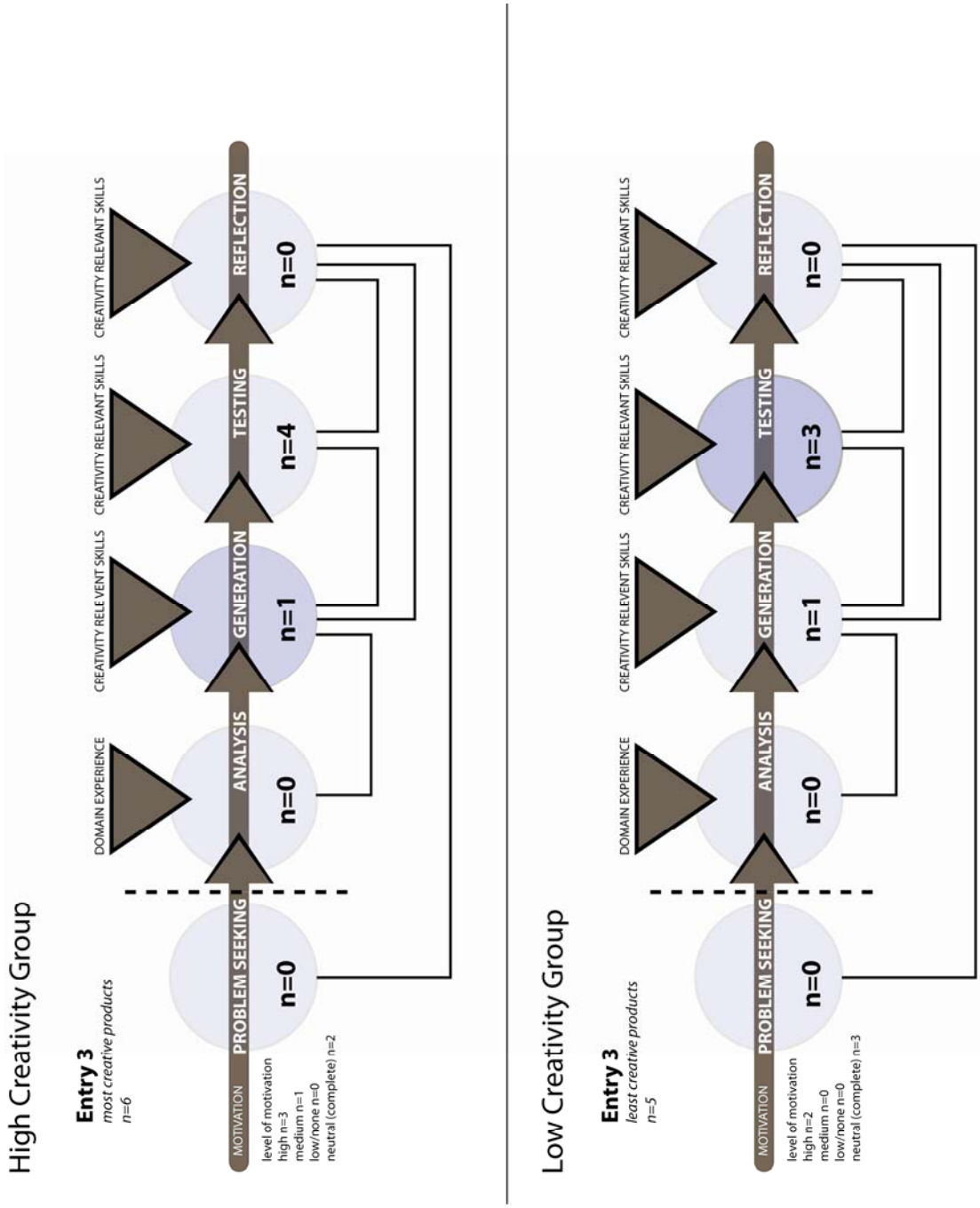

Figure 6.3. Entry 3: Comparison of process steps between high and low creativity groups.

Differences appeared to occur between the two groups within the types and degree of responses within the entries (see Figure 7.1). Students in the high creativity group appeared to seek greater diversity in information foci and sources. Students in the high creativity group also appeared more likely to seek sources beyond the internet or trade periodicals for their research (e.g. measurements, dialogue, end-user research, feedback). The relative degree of specificity regarding their task was higher in the high creativity group. Individuals in the low creativity group appeared to be more vague in response; citing information such as "online research." Those in the high creativity group were specific regarding what they were researching, why, and how the information would be utilized.

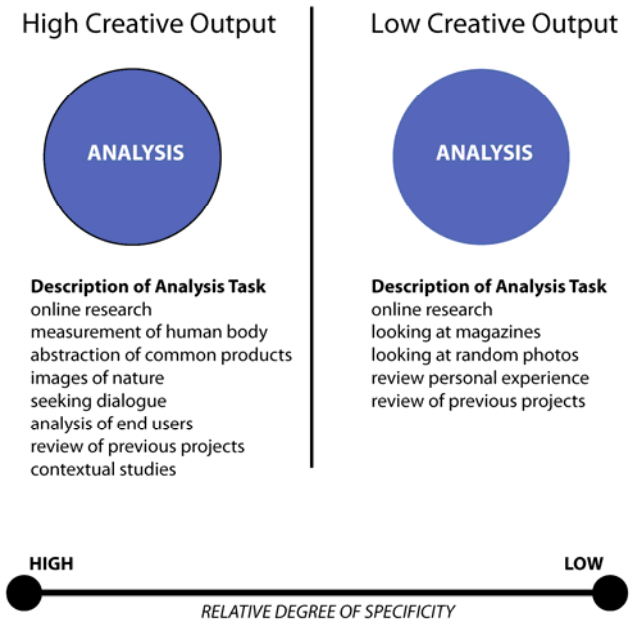

Figure 7.1. Comparison of analysis task between designated cohorts.

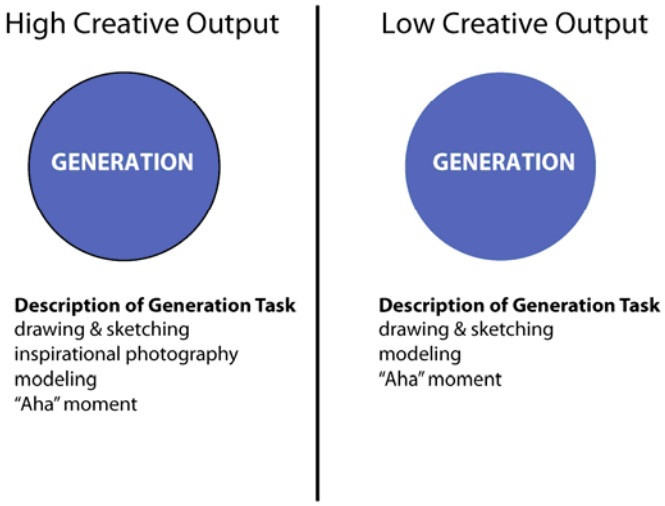

Figure 7.2. Comparison of generation task between designated cohorts.

Less distinction was found between the groups in the Generation Phase (see Figure 7.2). Both groups included students who perceived sudden inspiration as well as students who followed multiple iterations using more quotidian or smaller progressions toward the final design solution. When asked about areas of frustration in the process, individuals representing the high creativity group noted difficulties in editing ideas or "narrowing down" inspirations and conceptual references. The low creativity group identified slowness in actually manufacturing ideas or struggles with concrete issues such as model fabrication or time constraints. Neither group mentioned significant testing efforts. Testing for this particular project would have encompassed performing tasks either validating the selected product or causing actions to revisit previous stages in the process to develop a more appropriate solution. These actions would have created a feedback

loop to potentially improve the quality of the solution. There were also no mentions of self-initiated *Reflection* other than the assigned journaling prompts.

The fourth journaling prompt elicited responses focused on reflection, using remembered data about the entirety of the process. These reflections were compared between those in the high creativity group and those in the low creativity group.

Sample entry from student in high creative output cohort

> Initially, I searched for inspirational images on line, in books and magazines and blogs I follow. I knew I wanted to make a chair for two people and to really comment on the shapes and contours of the human body. I then became inspired by those little hand-made fortune telling games you make as a child. This was where I really started generating ideas of my chair. I made several of these fortune telling games out of paper and folded them in every possible way – playing with the angels, shapes, and forms created by changing the position of each fold and flap. I then took pictures of these conceptual models – studying them for possible positions that offered a "seat". This was all still very abstract. I researched materials and construction techniques of furniture to generate further ideas and began putting a model together in Sketchup to be able to manipulate it further. Along the way I generated ideas alongside conversations with my peers and relatives who were all helpful in inspiring and giving me honest feedback along the way.

Sample entry from student in low creative output cohort

> I generated ideas by researching what materials are recyclable and sustainable and what the basic need was for the assignment and end result of the chair.

These entries illustrated advanced levels of specificity in giving process detail for those in the high creativity group as well expanded conceptualization skills.

Product Outcome Analysis

The researcher analyzed products (i.e. scale furniture models and accompanying process boards) for differences and commonalities (see Figure 8.1 a 8.2) in quality between the groups. Those in the high creativity group illustrated abstract ideas informing the concept and ultimately the form of the chairs. Their final products included a level of changeability either in use or shape depending on current need or requirements.

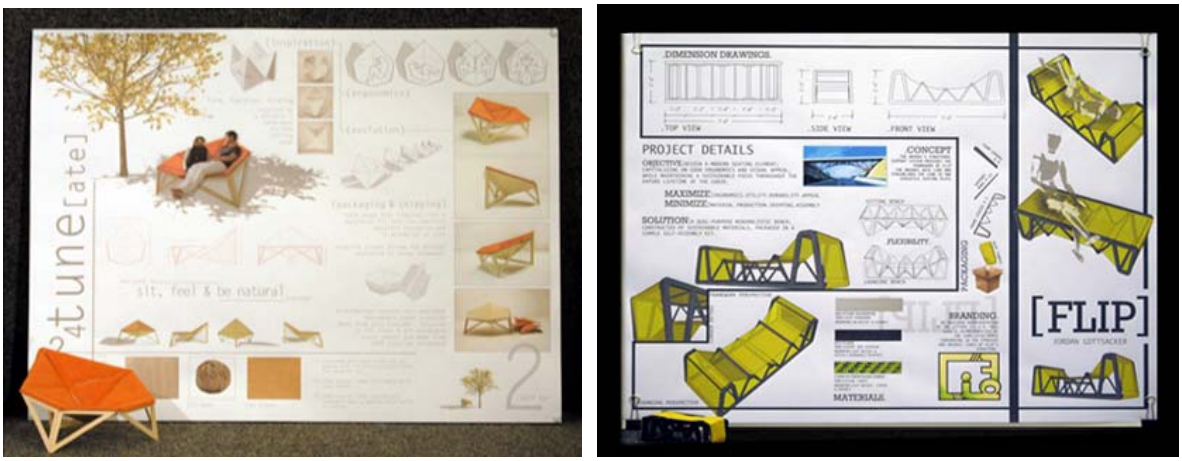

Figure 8.1. Selected images of product from high creativity group.

Figure 8.1 shows two representative project outcomes (scale model and process board) from the high creativity group. The student's process boards illustrated conceptual ideas (e.g., origami and bridge trusses) and indicated how the conceptual ideas evolved to inform the final design solution. The boards also indicate how an end-user(s) would engage the lounge chair. Solutions are indicated using multiple drawing types and the composition of the board used a variety of text styles and imagery. Scale models were well constructed and utilized saturated colors and multiple material types.

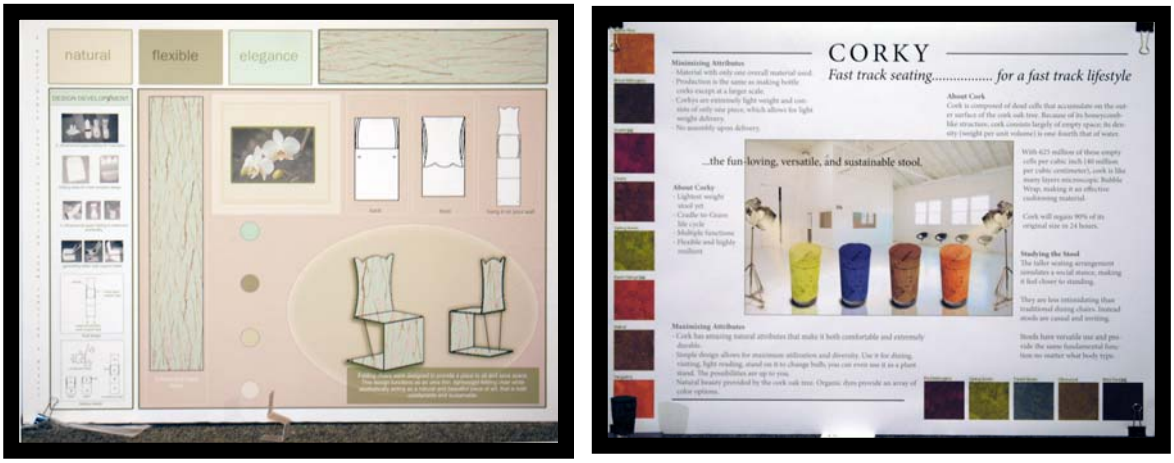

Figure 8.2. Selected images of product from low creativity group.

Figure 8.2 shows two representative project outcomes (scale model and process boards) from the low creativity group. The student's process boards indicated a limited relationship between their conceptual idea and the final form of the chair. The boards utilized less variation in composition and imagery. Their scale models were small and utilized one major material and little flexibility in form. The relationship between the end-user and the chair was not indicated.

The products of students in the low creative output cohort were relatively more concrete in usage (having one purpose) and their process boards illustrated less about their inspiration or concepts and focused more on materiality or usage.

Data Synthesis

Four research questions framed this explorative inquiry; each question is presented individually with a discussion of key themes and outcomes from the research.

Question 1

Q1: What stages of the design process are utilized by the student cohort?

From the examination of the student's responses (*N = 20),* two stages of the proposed design process model could be validated; other stages could not be confirmed.

Problem finding. The first phase of the design process has been defined as problem solving and is when an intrinsically motivated individual finds their own problem to solve for either the satisfaction or challenge of the problem itself and not for extrinsic factors. In this study the design problem was given; however, the manner in which the students interpreted the problem, required them to define a specific design challenge to solve (e.g., chair function, design). The project parameters and necessitation for assessment of work eliminated traditional problem finding opportunities.

Analysis. Students described analysis tasks during the process in terms of research via internet or trade periodicals, precedent and case studies, and exploration of project parameters, seating types, and environs. The highest level of participation of analysis task occurred during Entry 1 (*n* = 19) and the second highest occurred during Entry 2 (*n* = 6). This is not surprising as this is the sequence in which the students are trained to solve other design problems.

Generation. The students also described Generation tasks following Analysis. The highest levels of participation (*n* = 14) occurred during Entry 2; again following the sequence that the students are trained. Task included sketching, brainstorming, and creating inspiration photography. Most participants noted continued specific research conducted to support the tasks of the generative stage. Analysis and Generation were the two phases found to be the most reciprocal;

some participants implied cycling between the two stages several times before deciding on one design to document. Two students recounted “aha moments” while others either utilized quotidian steps that resulted in the fruition of their design concepts or did not identify the exact conditions surrounding design conceptualization.

Testing. Thirty percent of participants utilized some form of testing of ideas following their identification of an appropriate design solution. However, testing was minimal, and was explicitly utilized to explore relatively pragmatic factors such as hinging or assembly and not focusing on testing the design itself. This could have been due to concerns about time constraints or the impending assessment. Elimination of this stage could have detrimentally affected the product outcomes.

Reflection. A formalized phase of self-initiated reflection on the entirety of the process cannot be confirmed. No students recounted reflection on their own accord other than answering the predetermined prompts.

Question 2:

Q2: What activities of the process are similar or dissimilar?

Similar activities. Participants shared many common activities in deriving their design solutions. All students noted, at minimum, two stages of the proposed creative process model via responses indicating participation in *analysis* tasks leading to *generative* tasks. During analysis tasks, students utilized various research methods to better understand seating precedent, usage, or their own conceptual ideas. When proposed process stages could be validated, the actual sequence of task confirmed the arrangement of the proposed process model.

Limited presence of activities. Due to time constraints or workload pressures few students may have participated in activities testing their solutions; no students mentioned self-initiated reflective tasks.

Task involvement. The level of involvement in tasks appeared to vary considerably. During the analysis stage some students were vague about their research focus and the techniques utilized where others provided great specificity and obtained information from varied sources. Inputs into the process were similar; however to varying degrees. Most students sought feedback as they developed their solutions, and activities often included discussions with peers or mentors. Some students utilized the discussions in forming their designs while other discussed their products after realization.

Question 3

Q3: Are unique strategies implemented?

All student products evaluated were creative to a degree (the lowest score of 11). However, products varied in relative level of creativity, and several distinctions were noted between the high and low creativity groups:

Connection to previous projects or experiences. Students in the high creativity group formulated connections to previous projects more abstractly and transferred their previous design process skills from one project type to another. They noted despite not having previously designed furniture, they could implement similar procedures. Students in the low creativity group did not relate this particular project to any previous experiences or if so, related the project to more concrete

accounts; tying these experiences to discrete areas (e.g., pinpointing retail work experiences of unpacking merchandise to the chair assembly).

Divergent thinking. Students in the high creativity group utilized divergent thinking skills to a greater degree. This was reflected in their prompts on areas of research foci and inputs into the process. These students generally had three to four areas of research inquiry from the beginning of the assignment and added more specific inquiries to support the process where they thought appropriate. They were able to connect seemingly unrelated ideas to generate a cohesive design concept. (e.g., the lifestyles of persons living in metropolitan areas to the concept of the chair). A majority of students in the low creativity group noted research on concrete topics such as materiality or assembly.

Use of research. Students in the low creativity group utilized research to rationalize decisions. At times, they predetermined the use of a specific material to later research that material's appropriateness for the design. The implication of this method is rigidity in design thinking and using information to qualify decisions that had previously been determined in lieu of using information sets to develop questions and subsequent explorations.

Question 4

Q4: Do certain influences produce a better product?

Comparative analysis of the two student groups (high creativity group and low creativity group) led to several process distinctions which may have been precursors to higher levels of creative output.

Analysis task. The students in the high creativity group utilized multiple analysis techniques, and brought together discrete ideas to form a unified concept. Students in this group demonstrated cognitive activities including utilization of theory, careful thought about the human form, and abstraction from ordinary objects. Their counterparts typically, concluded their research activities with precedent studies. The high creative output group also referenced more instances of human factor studies and mentioned increased and earlier interest in the end-users, natural elements, or ergonomic issues. Their counterparts were generally more vague about resources; using more simplistic descriptors such as “online research”, viewing previous competition submissions, or “looking at pictures”.

Domain experience. Students in the high creativity group had more transfer and total credit hours, as well as higher GPAs. This group of students reflected facile learning transfer and noted an ease in reconciliation of the process of furniture design to that of previous endeavors. Students in the high creativity group appeared to be able to find intangible similarities to previous projects and experiences while students in the low creativity group recounted relatively concrete experiences such as a negative experience of moving furniture or positive experiences with other chairs and seating types. This data suggests that increased levels of domain experience appear to coincide with increased creative output.

Generative task. Despite utilizing similar tasks in the generation phase including: sketching, brainstorming, and modeling; a significant distinction was revealed when the students were asked about the occurrence of frustration during the project. Both cohorts mentioned frustrating encounters; however, the cause of

these frustrations differed between groups. The high creativity group reported problems in eliminating a multitude of ideas or did not want to select a single idea to document. These students deflated frustration levels by a change of scenery or "stepping back" from the project. This relates to high levels of creative relevant skills or being able to abandon unproductive ideas and having the work ethic to find ways to continue or find more productive strategies.

The group with less creative products struggled with "road blocks" where ideas or inspirations were slow in coming. The students also struggled with more concrete issues such as model fabrication or material selection.

Motivation. Both the high creativity group and the low creativity group exemplified generally high levels of motivation. Students felt the project was novel and allowed them to explore unique parameters and opportunities. Students indicated excitement to add their chair projects to their design portfolios or wanted to further explore the discipline of furniture design for future career opportunities. No explicit distinction in motivation levels was revealed between high creativity and low creativity groups.

Testing. Due to time constraints neither high nor low creativity group readily participated in a formal phase of testing an idea. Testing occurred only at relatively trivial levels and was initiated to explore specific, explicit, criteria and not to test the overall solution itself. This may be due to fears of high lighting issues which could have resulted in poor assessments or perceptions regarding project timeframe.

Reflection. An unanticipated measure of creative output was the elaboration of the prompt responses themselves. The high creativity group averaged 414 words

per entry and the low creativity group averaged 388 words per entry. This may be attributed to breadth and depth in exploration of the high creativity group or to the vagueness of response found in the low creativity group. It is unclear if there is a relationship between higher levels of writings skills to higher levels of creativity.

Proposed Model

The proposed creative process model requires further testing to elicit data on stages of Problem Seeking, Testing, and Reflection; as well as more information confirming the presence of Ambile's (1996) Components of Creativity regarding relative levels of creative output. The stages of Analysis and Generation were validated in the study and at this time no changes need to be made to the proposed model.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

This study was conducted to explore and define a practice-based sequence of actions which would result in higher levels of creative output by fourth year interior design students. The study considered Amabile's (1996) Components of Creativity as well as a proposed design process model resulting from commonalities found during a survey of ten seminal and contemporary creative process models.

In the study, participants engaged in both *Analysis* and *Generative* task during the course of the project assignment. The presence of these tasks supports the proposed model. Due to the given project statement and possible constraints and limitations other phases of the process could not be confirmed for *Problem Seeking, Testing, and Reflection.* The level of breadth and depth of the analysis activities appeared to result in varying levels of creativity in the designed products.

Scores from external evaluators were analyzed and identified two groups (high creativity output and low creativity). The group displaying high creative output demonstrated more divergent thinking skills, research foci, and depth of thought. They were able to relate to the project in abstract terms and utilize similar processes of those used during previous experiences.

Students in the low creativity group struggled in relating the project to previous experiences or related to concrete accounts and very specific frames of reference.

Characteristics of the student participants in the high creativity group included higher levels of:

a) *Abstract thought;*
    - Ability to bring seemingly disparate ideas together; and,
    - Ability to relate the project to previous design problem solving experiences.

b) *Divergent thinking;*
    - Ability to utilize multiple research sources to develop a unified conceptual idea;
    - Ability to utilize and synthesize multiple or diverse analysis techniques to solve the problem; and,
    - Ability to formulate multiple design solutions.

The student's processes also demonstrated:

a) *Depth in thought utilizing domain experience;*
    - Ability to isolate and explore specific cognitive paths; and,
    - Greater background knowledge (e.g. credit hours)

b) *High work ethic exemplifying high levels of motivation;*
    - Ability to self examine and remove oneself from process to later revisit the design; and,
    - Ability to deal productively and appropriately with frustrations

Study Limitations

Several limitations may have impacted the findings reported in this study.

Data Collection Limitations

Limitations potentially affecting data collection and analysis of data during the study included: a convenience sample, levels of commitment from the students regarding the journaling prompts, potential for coding errors in the analysis of data, and potential subjectiveness of external evaluators. External evaluators were asked to judge design solutions based upon their own assessments regarding level of novelness and appropriateness of each solution. An inherent level of subjectiveness is imbedded within this type of assessment.

Census size. The participant population was also smaller than expected. This was due to the time sensitive nature of the journal responses. Entries that were not collected within 24 hours after each intervention were eliminated from the study leaving only 20 participants (two students opted not to participate and 14 did not respond within the required timeframe for at least one of the four interventions).

Study structure. The structure of the study also produced limitations. Due to the student population, a very homogenous population participated, and findings were limited to an all female, primarily Caucasian, similar age, and primarily a Colorado residency group. Information was not ascertained regarding specific design experiences and unique backgrounds which may have affected the data. Due to the student demographics the data is not generalizable to other populations.

Also a small number of external evaluators were utilized. Given this number and inherent subjectiveness of evaluations results, could have been skewed due to personal opinion or other influencing factors.

Journaling responses. During the study journaling questions did not always generate the type of data expected. Little data was compiled on the generative stage of the process. This may have been due to the timing of the prompts; for many participants generative tasks occurred too far between interventions to fully capture with the prompts.

Situational Influences

Circumstances and influences surrounding the study could have also skewed the reported findings.

Student stress. In the response prompts, many students mentioned high stress levels due to workload from other courses; these pressures may have led to a shorter duration in design process with limited time to explore diverse cognitive pathways. Student fatigue due to the perceived heavy workload in other courses may have impacted the study. The students had two weeks to both generate design ideas and produce deliverables for a product in which they weren't familiar. This led many participants to judge their progress based on the given time frame or through competitive comparison with peers regarding level of work they had completed. This perceived short time frame may have led students to greater brevity in the process steps than may have otherwise been taken. The timeframe may have also led students to eliminate any testing of their products to avoid highlighting issues that may have potentially led to a late assignment or poor grade.

Extrinsic motivation. Another limitation to the study was that students were graded upon their design solutions. Grading, as an extrinsic motivator research has indicated to be detrimental to creative output, may have influenced the responses, as well as the unknown influences of identified (positive) external motivators of doing a project the participants felt was for the good of their portfolio.. The knowledge of impending assessments may have also skewed the student's responses and determinately impacted levels of intrinsic motivation.

Implications

The development and documentation of a realistic, practice-based design, process model that considers both the sequence and types of actions taken and decisions made that result in higher levels of creative output would greatly benefit design students, practitioners and their clients. The implications tie most immediately to design pedagogy.

Pedagogical Implications

This study is useful as a starting point for future pedagogical research specific to creativity and the design process within the discipline of interior design. If design instructors understood more about the process their students utilized, they could more effectively and specifically encourage and stimulate students in exploration of breadth and depth of thinking. This expanded exploration may result in the output of design product perceived to be relatively more creative. If students understood the value of additional domain experience and disparate coursework they may seek to acquire additional courses expanding their background

knowledge. Design instructors can enhance student performance by the following measures:

Abstract thought. Increased exposure, experience, and synthesis of abstract thought could be ascertained when design instructors encourage students to relate seemingly disparate ideas through metaphorical approaches to conceptual design. Classroom exercises could include divergent thinking drills. Instructors could ask students to relate a current project to previous design experiences. These discussions could help students to develop coping strategies for potential frustration.

Divergent thinking. Encourage students to access multiple sources to develop design concepts and promote the exploration of areas outside the domain of interior design. Design instructors could set minimum number of research foci prior to the start of a given project. Encourage students to utilize a combination of multiple analysis techniques; to do so instructors could require students to leverage sources other than the internet as part of their analysis methods. Interior design instructors need to encourage students to also develop multiple design solutions. This could be done by assigning two variations of the same design problem, to later combine best attributes into final designed products. When a project is thought to be complete ask students critically examine the output and to start the process again utilizing new knowledge ascertained from their analysis.

Depth in thought and action. Encourage exploration of specific cognitive pathways. Instructors can model critical thinking by making their own thought processes explicit. After knowledge has been shared, require students to repeat

the recently acquired knowledge in their own terms. Challenge students to investigate ideas further than originally anticipated by asking multiple open-ended questions in order to develop a lively dialogue about what has been learned. Instructors can ask them to describe how they arrived to their current point in the process. Discuss with students the potential implications of their decisions and ground their knowledge to real world context.

Work ethic. To encourage high levels of intrinsic motivation, instructors need to encourage self-examination and removal of oneself from process in order to revisit the design. This could be done by assigning a separate design problem during the course of the first assignment. This relief from the initial design problem could help students subconsciously develop design solutions. Discuss with students effective methods to alleviate potential problems resulting from both too many and too few ideas.

Recommendations for Future Research

The subject of creativity in the design process is broad and complex with many potential areas of study. Based on this review of literature and the findings of this study, students, instructors, and practicing designers would benefit from expanded research in these areas to be better equipped for competitive environments. This study could be expanded to include a larger sample; including a longitudinal study with three to four consecutive cohorts of students. The study population could include students from other universities to allow for greater diversity of backgrounds and educational experiences.

Components of Creativity

A study could be conducted comparing a younger cohort of students with more senior level students. Further studies could include more advanced students against a cohort of practicing designers. These studies would examine the effects of increased domain experience on process steps, tasks involvement, and product outcomes.

Multiple studies could be conducted on variables including: assessment techniques, critique strategies, and competitive factors; to explore tangible pedagogical methods that increase intrinsic motivation in interior design students.

Studies need to be conducted on how students explore complex and unrelated phenomena to develop design concepts. Students who are able to reach beyond the tangible concrete design metrics often produce designed products that are relatively more creative than their counterparts. Methods on how these cognitive pathways can be encouraged could greatly benefit struggling students.

Process

Comparison studies should be conducted to examine differences between design process stages and activities in allied disciplines. These insights could be incorporated into future pedagogical works allowing students to explore the process through a lens of related domain. This diversity in experience could assist students in finding methods and processes most beneficial for their specific needs.

Further exploration should be conducted to clarify specific tasks within each stage of the design process. Research could be conducted on the correlation between the strength and depth of analysis techniques to the diversity and plasticity of product outcomes. More information needs to be revealed about the generative activities of the process; specifically, if students experienced sudden illuminating thoughts or utilized quotidian steps to develop their designs.

Advanced research needs to be conducted on how best to encourage students to test their ideas. What presses could be increased or alleviated to increase time spent on critical thinking and product evaluation? Studies could determine how factors such as additional time or fewer required deliverables change student perception regarding priorities of the process, and encourage more rigorous and specific testing of products before they are finalized.

A study could be conducted on the use of reflection to advance the process. Studying which methods or types of questioning prompts would elicit increased creativity in product outcomes could benefit instructors in increasing level of creativity in student's products.

Inputs into the process. With advancements in technology and paradoxically less available equipment due to funding shortages; many students are more apt to work independently at home, thereby decreasing the opportunity for dialogue and comparison amongst students engaged in the design process. The role of inputs into the process should be explored to examine if students who sought more information or dialogue utilized this feedback to return to previous stages; and, if so, to what degree does this enhance their design products. The level of

receptivity to feedback and measuring the degree of feedback utilization for advancement of design products should be researched. Further studies could explore how feedback could alleviate frustrations encountered during the design process.

The role of heuristics in the process; do students utilize shortcuts in navigating process stages? Does a higher level of domain experience increase the usage of heuristics, to what degree, and success level?

The role of research into the process should be examined. With a greater ease of ascertaining precedent images, case studies, or even specific information on materials and ergonomics; does the added information advance or constrain the process through increased utilization of both trade and empirical research? Studies could be conducted on how, and when, information utilization occurs; either at specific points in the process or throughout the entirety of the process. At what point does this added information over-constrain the student thereby limiting creative output?

In this study students in the high creativity group demonstrated longer and more explicit journal responses. Studies could be conducted to determine if there is a relationship between level of writing skill and comprehension to level of creative output.

Demands on the process. The role of time constraints on the process should be examined. If students are given longer time frames does this change the steps and depth of the process and to what degree does added time change the quality of the designed product. Or do students utilize the extra time for other

projects or extracurricular activities? The role of competitive judgments could be researched. During this study many students judged their own progress not on internally set metrics but based upon the progress of others. Does this competitive assessment technique help advance the process or does it cause the student to rush critical process steps; mediating the creative output in the final designed product?

In this study participants to who not respond to journal prompts within the 24 hours allotted after each intervention were eliminated for the entirety of the study. Comparison could be conducted to see if students who were delayed response demonstrated increased or decreased presence of Amabile's (1996) Components of Creativity or changed process sequences and level of task involvement.

Summary

As an exploratory study this research only began to examine the creative process and tasks resulting in higher levels of creative output. Findings from the study indicate similarities in process steps utilized by all students; however discrete differences arise when comparing the depth of task involvement of students in the high creativity group with those in the low creativity group. Design instructors can utilize findings from this study in further explorations on how best to enhance abstract thought, divergent thinking, motivation levels, and depth in thought and action. These enhancements can aid students in designing product outcomes that are relatively more creative.

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APPENDIX A

Letter of Consent

Name_____

Signature_____

Date

Dear Participant

My name is Amy Mattingly and I am a researcher and graduate student in the department of Design and Merchandising here at Colorado State University. We are conducting a comparison study to research to the stages of and actions taken while within the design process. The Principal Investigator (PI) is Katharine Leigh, a professor within the department of Design and Merchandising and I am serving as the Co-Principal Investigator.

During the course of the INTD 400 chair design project we would like you to answer several questions following email prompts which you will receive six (6) times during the project. The nature of these questions will only gauge your progress and thoughts processes while working on the project and will not be probing into any personal or private matters. In addition to the questions we would like you to share your project design journals for evaluation. Your participation in this project is voluntary and should you decide to participate in the study, you may withdraw your consent and stop participation at anytime without penalty. Your grade will in no way be impacted by your participation in the study. Demographic data will be obtained regarding your year in school, GPA, and coursework. However, your name and identification will remain private and all data will be maintained within a locked cabinet by the PI, therefore you may be assured confidentiality.

Although there may be no direct benefits to you for participating in the survey you may enjoy and gain knowledge from taking part in both the questions. By conducting this research it is our hope to gain a better understanding of the design process in order to facilitate future teaching and improve the student's design products. Finally, while is not possible to fully identify all potential risk involved in these research procedures, the researcher(s) have taken reasonable safeguards to minimize any known and potential unknown risk to the participants.

By signing on the line above you give your consent to participate. We greatly appreciate your participation. If you have any questions or concerns regarding the research either at this point or at any time during the future, please feel free to contact me at 720.371.3252 or Professor Leigh at 970.491.5042. We would be happy to respond to your questions or concerns. If you have any questions regarding your rights as a volunteer in this research please contact Janell Barker, Human Research Administrator, at 970.491.1655.

This consent form was approved by the CSU Institutional Review Board for the protection of the human subjects in the research on DATE.

Thank you in advance, for your valuable assistance.

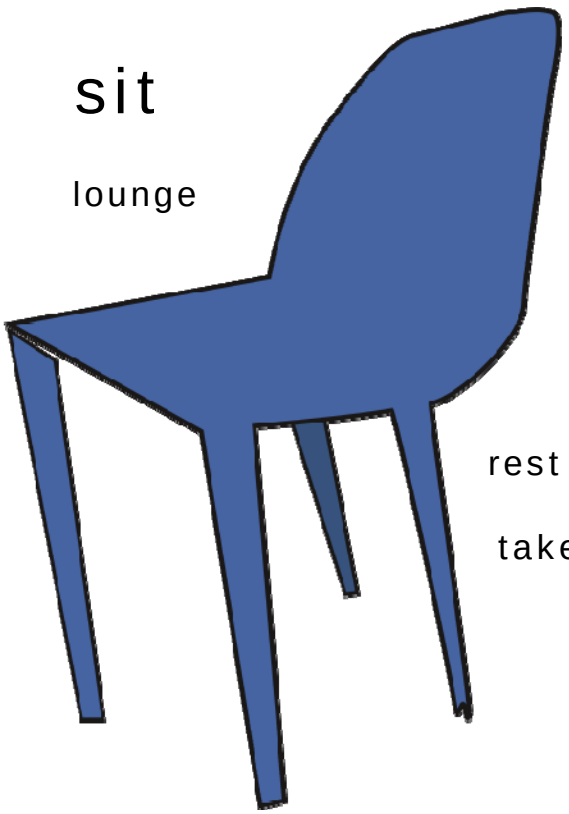
Sincerely,

Amy Mattingly, LEED AP, IDEC, Graduate Student
Co-Principal Investigator

Katharine Leigh, LEED AP, Professor
Principal Investigator

APPENDIX B

Assignment Statement



“Beauty rests on necessities.”
…Ralph Waldo Emerson

intro

The aim of this project is to not only to produce a beautiful, functional, and comfortable seating element but one with sustainability in mind. Not an act of compromise but push both aesthetics and sustainability in new directions.

How little material can you use to make the most of a chair?

How little packaging can you use to reach the most people?

Can you design a chair that is almost nothing and almost everything at the same time?

	MINIMIZE	**MAXIMIZE**
a.	Material	Comfort
b.	Production	Utility
c.	Shipping	Durability
d.	Assembly	Beauty

criteria

Successful projects will be clear, compelling, innovative designs that demonstrate three criteria:

Make good (Material conservation). How can shape optimize resources, fabrication, and shipping? What forms create little waste but lots of taste?

Feel good (Physical comfort). How can shape aid the body in the act of sitting? How do different people sit? How might they in this piece?

Look good (Emotional resonance). What kinds of images create emotional bond between viewer and product? What is the intersection of sustainability and sensuality?

deliverables

You will have three weeks to design, document your design process and finally produce both a 1/2”=1’-0” scaled model and 18 x 24” design process board.

You will also be asked to participate in a study regarding your design process. Your participation is voluntary and your grade will not be impacted based upon your participation.

schedule

WEEK ONE Project introduction, research, program development

WEEK TWO Design development, presentation preparation and delivery

additional information

http://www.onegoodchair.com/home/

http://www.treehugger.com/files/2008/03/one-good-chair-furniture-design-competition.php

APPENDIX C

Questioning Matrix

Component of Creativity	1 Initial	2	3	4 Final
	Week 1: Monday	**Week 1: Wednesday**	**Week 2: Monday**	**Week 3: Wednesday**
Creativity Relevant Skills	What will inspire your project idea? How will you acquire ideas for the project? What are your next steps?	Describe where you are currently in the project? Was there a point where you have felt frustrated or weren't making progress? If so, what steps did you take to move forward? What have you accomplished at this point? What are your next steps?	Describe where you are currently in the project? What have you done to bring you to this point? What are your next steps?	Describe how you generated ideas for the project? Did you seek feedback or dialogue regarding the project? Describe the feedback you received on your idea and delivery of the project and from whom.
Domain Relevant Skills	In your own words describe the design problem that needs a solution. How will you start the design of this project? Can you relate this to any previous works?	How are you judging your progress? Can you relate your design work to a previous experience you have had?	How are you judging your progress? Has research informed your design up to this point? Please describe how this influenced the design.	Have any of your previous experiences informed the design of this project? What do you wish you would have known/researched prior to the start of this project?

Component of Creativity	1 Initial	2	3	4 Final
	Week 1: Monday	**Week 1: Wednesday**	**Week 2: Monday**	**Week 3: Wednesday**
Motivation	How interesting is this project to you?	How do you feel about the work you have completed? How excited are you about moving this project to the next stage?	How do you feel about the work you have completed? How excited are you about moving this project to the next stage? How will this project inform your future career?	How do you feel about this project now that it is complete? If given the time would you make any further changes?

APPENDIX D

Human Subject Approval Letter

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	December 13, 2010
TO:	Leigh, Katharine, Design and Merchandising Mattingly, Amy, Design & Merchandising, Tremblay, Kenneth, Design and Merchandising, Littrell, Mary, Design and Merchandising
FROM:	Barker, Janell, CSU IRB 2
PROTOCOL TITLE:	Mind and method: An examination of the cognitive activities in the design process.
FUNDING SOURCE:	NONE
PROTOCOL NUMBER:	10-2114H
APPROVAL PERIOD:	Approval Date: December 01, 2010 Expiration Date: November 30, 2011

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Mind and method: An examination of the cognitive activities in the design process.. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Research.Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Research.Colostate.edu

Barker, Janell

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

Barker, Janell

Includes:
Approval is to recruit up to 36 students from INTD 400 with the approved consent form. The above-referenced project was approved by the Institutional Review Board with the condition that the approved consent form is signed by the subjects and each subject is given a copy of the form. NO changes may be made to this document without first obtaining the approval of the IRB.

Approval Period:	December 01, 2010 through November 30, 2011
Review Type:	EXPEDITED
IRB Number:	00000202

APPENDIX E

External Evaluator Criteria

Evaluation Questions-*adapted from One Good Chair Competition Criteria*

Level of Novelty

Is the design unique, is it innovative?

Level of appropriateness

Make good (Material conversation). How can shape optimize resources, fabrication, and shipping? What forms create little waste but lots of taste?

Feel good (Physical comfort). How can shape aid the body in the act of sitting? How do different people sit? How might they sit in this piece?

Look good (Emotional resonance). What kinds of images create an emotional bond between viewer and product? What is the intersection between sustainability and sensuality?

Design #1	Low				High
Novelty	1	2	3	4	5
Appropriateness	1	2	3	4	5